Chemical Engineering
APRIL
TESTING TECHNIQUES
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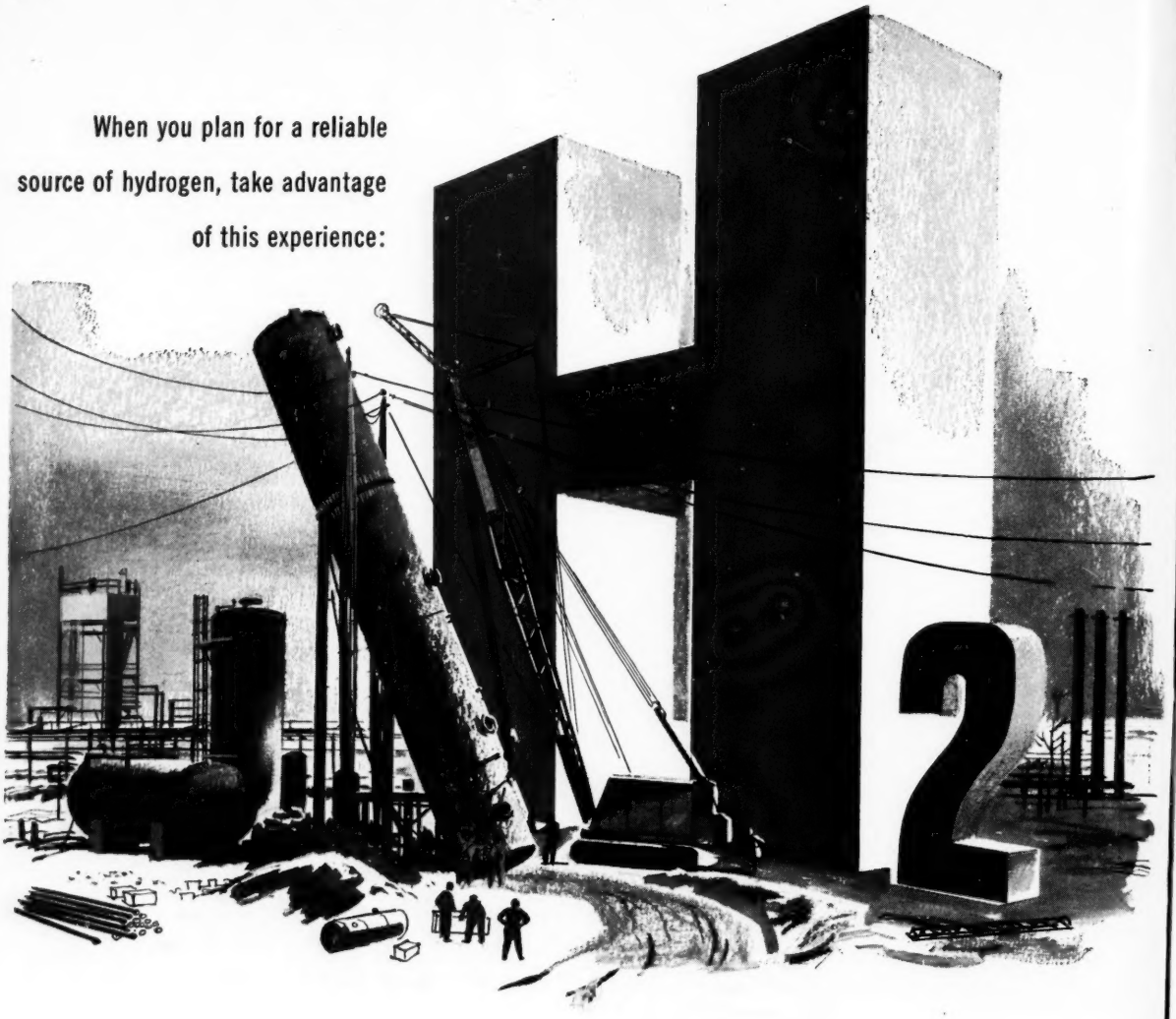
Nondestructive testing techniques
New concepts in ejector applications
How to select your best pump seal
SEE PAGE 3

XUM

When you plan for a reliable source of hydrogen, take advantage of this experience:



More than 50 hydrogen plants have been built by Girdler

In your search for *experienced* engineer-constructors to provide dependable hydrogen facilities, let these facts guide you: Girdler has built most of America's hydrogen plant capacity installed during the past ten years. Big and small . . . for low-purity or for high-purity hydrogen . . . these plants provide undisputed evidence of Girdler's know-how and ability. Call or write us for complete information.

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A DIVISION OF NATIONAL CYLINDER GAS COMPANY
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XUM

APRIL 1957

JOHN R. CALLAHAM, Editor-in-Chief

More Cost Data Needed!

Ten years ago you could count on your fingers the number of top-notch articles on costs and cost estimating methods that had appeared in the chemical literature.

But since 1947, CE alone has published 102 articles—close to 430 pages—on costs, cost estimation and engineering economics. Other magazines in the petroleum and chemical field have also made noteworthy contributions.

Still there are vast gaps to be filled. The need for reliable cost data is more urgent today than ever before.

What kind of material is most needed? Not more on estimating methods. Plenty has been written on these, and there have been few major advances since Becket's pioneering article in *Chem. & Met* in 1926.

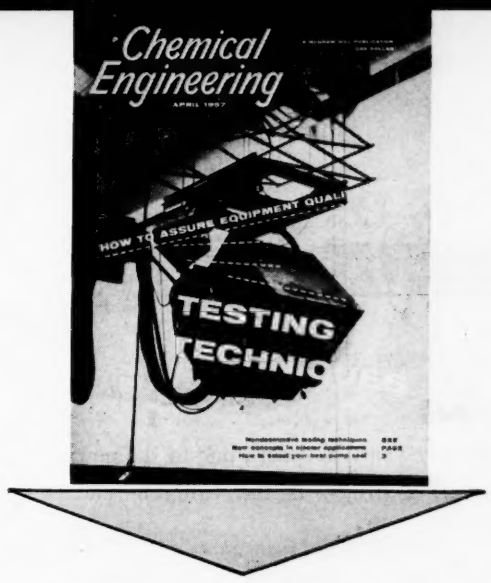
What's needed now is more cost data—specific data—on all sorts of equipment, facilities, operations. And the big need is for data correlations—the more the better!

This is where we're hoping some of you might come into the picture. Do you (or your company) have good cost information stashed away in files or notebooks? The type that's not confidential, but that would be of help to other engineers throughout the process industries?

If so, won't you take the time and trouble to update it and to put it into publishable form?

We're making this appeal because you, our readers, are constantly asking for our help: more and more articles on costs and cost correlations.

If you're able—and willing—to contribute, we'd be glad to discuss your ideas with you and to help out in any way we can.



GUIDED TOUR

Making sure that your process equipment is good enough

How modern techniques of nondestructive testing help you decide that materials and equipment meet proper quality standards. Our over-all evaluation of various testing methods emphasizes the need for analyzing these quality standards to make your plant economically safe. (p. 261)

First details on a new process

Just revealed: equipment and operating details of a solvent extraction process for uranium recovery. Experience favors solvent extraction over ion exchange for this application. (p. 148)

Flowsheet for tranquility

Pictures, text and flowsheet tell how a commercial plant is operating at the rate

Chemical

GUIDED TOUR

of a ton per year. Serpasil, one of the new tranquilizing drugs, is the valuable end product. (p. 230)

New guide to pump seal selection

All pressures, all temperatures and all liquids commonly met today are covered in your CE Report. Tabular guides will steer you quickly to the best answer to all your pump sealing problems. (p. 239)

Progress in steam jet ejectors

There's an entirely new concept in the study of vacuum producers. It's helping ejectors carve a bigger place in industry. See how new multistage systems can ease your design problems. (p. 255)

How to help your own advancement

You can advance yourself professionally by improving your record of technical publications. Expert advice from the editors of 25 technical magazines will help you get more articles published. (p. 313)

To keep pace with development, design, production and technical management in the chemical process industries, more engineers subscribe to CE than to any other magazine in the field. Paid circulation of this issue:

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Chemical Engineering (with Chemical & Metallurgical Engineering) is published monthly with an additional issue in Mid-September by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

▶**Executive, Editorial and Advertising:** 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

▶**Subscriptions:** Write to Chemical Engineering—Subscription Service, 330 West 42nd St., New York 36, N. Y. Allow one month for change of address. Please show position and company connection on all orders.

Single copies $1 in U. S., possessions and Canada; $2 in all other countries. U. S. and possessions, $3 per year, $4 for two years, $5 for three years; Canada, $4 per year, $6 for two years, $8 for three years; other Western Hemisphere and the Philippines, $15 per year, $25 for two years, $30 for three years; all others: $25 per year, $40 for two years, $50 for three years.

Second class mail privileges authorized at Albany, N. Y. Printed in U.S.A.

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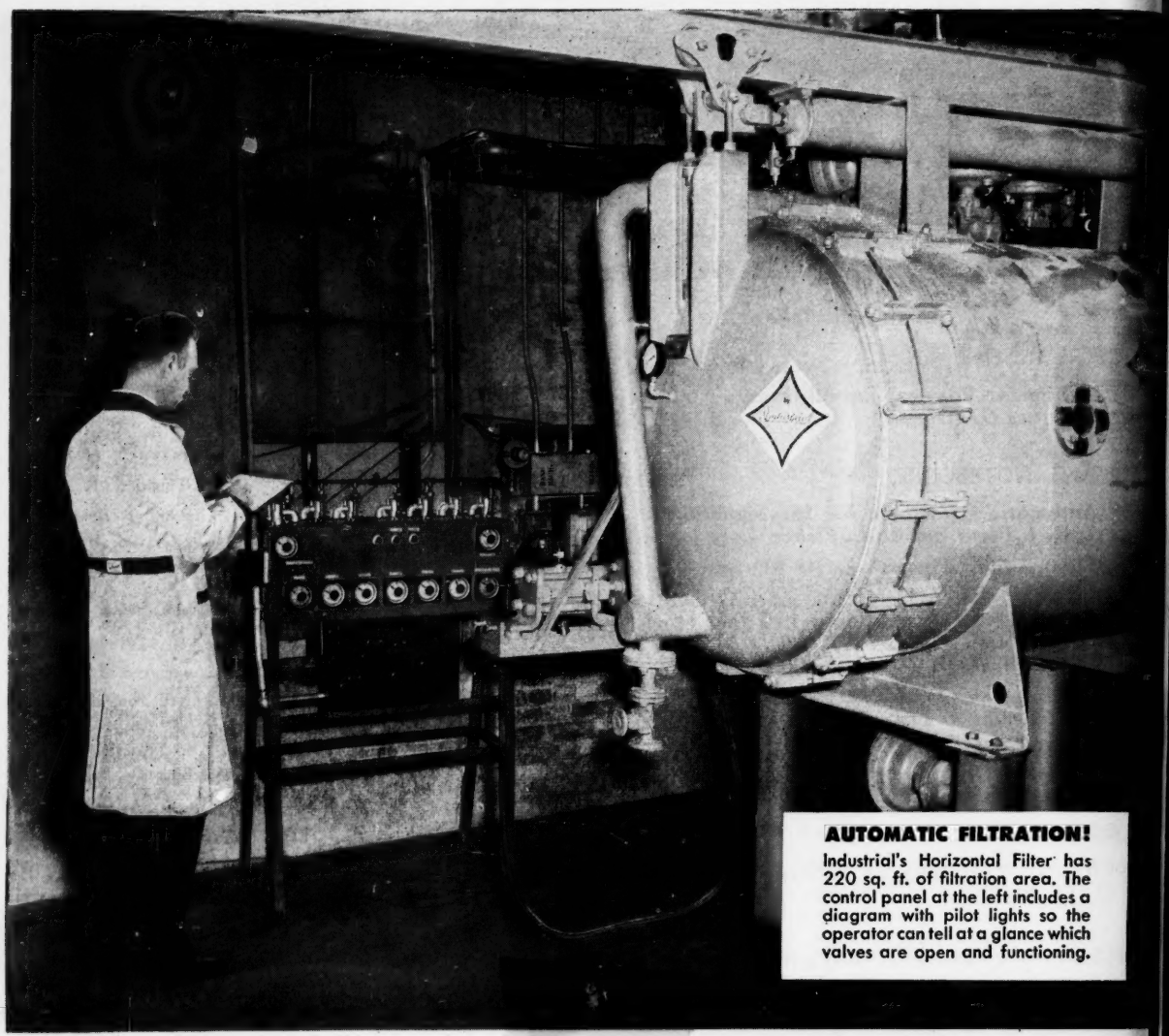

AUTOMATIC FILTRATION!
Industrial's Horizontal Filter has 220 sq. ft. of filtration area. The control panel at the left includes a diagram with pilot lights so the operator can tell at a glance which valves are open and functioning.

Different processes...different filters... all by Industrial

Wide range of filter types and specific engineering delivers efficient filtration for any process.

Automation tunes filter to peak efficiency at all steps in operating cycle

This Industrial filter is engineered to provide unusually complete control in filtering hot "thick" sugar liquor. The automatic controls can be set to carry out a complete cycle during which the filter fills, precoats, filters, drains, fills for shaking with a "thin" juice, shakes the filter cake off the leaves, drains off filter cake, sluices and starts to precoat again.

Automation All controls can be preset as desired to time each part of the cycle. The cleaning cycle can be started either by a timer or by a switch activated by pressure on filter cake. Variations in cycle can be obtained by simply adjusting dials and all automatic controls can be cut out for semi-automatic operation by toggle switches.

The process This filter is used to clarify sugar liquor in the second process stage. Here the sugar fluid has already gone thru one filtering operation and has been reduced by evaporation. The fluid is hot (about 150° F) and its viscosity permits a flow rate around 13.5 gallons per square foot per hour or 3000 gallons per hour for the filter. The sugar will go thru several more evaporation and filtering operations before it is ready for use as syrup or made into crystals.

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So far, Kerr-McGee prefers solvent extraction over ion exchange to pluck uranium out of acid-leach liquor.

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A simple technique—with great potential versatility—Bismuth plugs measure heat flow through porous solids.

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Shea's double-shell design captures wasted Btu.'s, slims radiation losses and smooths temperature changes, too.

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Udy arc furnace process now gleans ferromanganese from low-grade ores; may tap other ores and wastes soon.

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Ion retardation—new simple method turned up by Dow—hinges on use of resin with anionic and cationic sites.

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Report on chemical profits 204

A not uncommon economic picture today: Sales gains make great strides while profits just mope along.

Sulfur output and competition up 208

Though still king of the sulfur block, U. S. industry is tasting its first world-wide challenge in 60 years.

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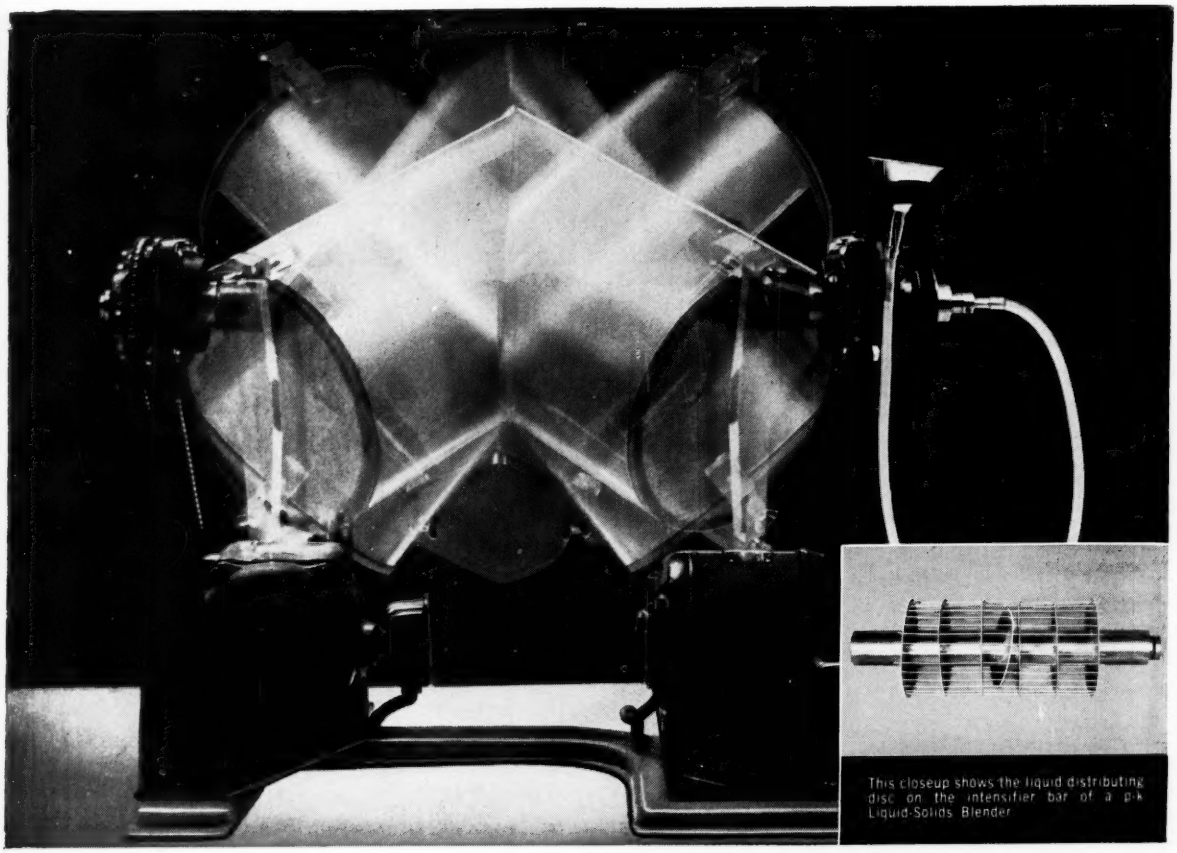

P-K Liquid-Solids* Blender Creates New Production Concept!

A new, revolutionary method for blending liquids into dry materials is highly successful in practically all chemical and process applications.

Essentially, the p-k Liquid-Solids blender operates in the following manner. Liquids, regardless of viscosity, are introduced into a rapidly revolving bar (by gravity or pump). The liquid is flung outward in a finely divided state from a distributor disc and feeds a continuous fine spray into the tumbling mass of dry materials as the shell rotates. A series of stainless steel wires, strung horizontally along the bar, prevents the formation of agglomerates and further promotes liquid dispersion.

This unique blending operation can be accomplished in *minutes* and eliminates costly, time consuming steps, such as screening, pulverizing and mulling. With the p-k Liquid-Solids blender, you will get a fast, one step operation that guarantees *consistent* blending *uniformity* not otherwise obtainable.

The exclusive p-k dry mechanical seal prevents materials from entering the bearing housing and protects against product contamination. Two vapor and dust-tight quick-opening covers allow easy access to the baffle-free interior for cleaning. The p-k Liquid-Solids blender is available in sizes ranging from 1 to 50 cubic feet working capacity.

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Patterson Kelley
Chemical and Process Division

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Investigate P-K's Blending Concept

P-K's Customer Service Laboratory will be pleased to test-blend your materials . . . preferably under your supervision. Material formulations will be blended to your exact specifications and returned for analysis, together with a complete report. P-K recommends pre-tests for all "Liquid-Solids" applications, because of the many variables that may affect blending procedures necessary for intimate dispersion of liquids in solids. Our Lab also conducts comparison tests in pilot models of all other basic blender types . . . from ribbon and double cone to p-k's standard Twin Shell and "Intensifier" models.

All of them are members of a growing family of p-k blenders and all are described in our new catalog 14. Write our Mr. R. T. Dotter for your copy . . . and arrange, too, for a pre-test of your materials.

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DEVELOPMENTS . . .

APRIL 1957

Chementator

C. H. CHILTON

√ **Shell Chemical is building a British ammonia plant which will use a new pressure process for converting liquid hydrocarbons into synthesis gas. Noncatalytic process, already in successful use in the Netherlands, uses either enriched air or oxygen.**

√ **Thermal diffusion research at University of Tennessee gets a big boost via a $25,000 contract with Union Carbide. Investigators will use new horizontal column in trying to separate metallic salts.**

√ **Latest idea in infrared process heating is use of multifrequency radiation. Special ceramic sheath surrounding electrical resistor converts usual narrow frequency band into one covering range of 2 to 10 microns.**

Natural radiation controls processes

Process control by radioactive tracing has taken a new twist. Instead of using an artificial isotope, International Minerals & Chemical keeps tabs on potash and feldspar beneficiation operations by measuring the beta-ray emission of K-40. This radioactive isotope comprises 0.011% of natural potassium.

IMC is using this technique on a production basis at two different plants. Radiation from a moving stream of mineral is detected with a Geiger counter and translated into K_2O analysis.

Ion exchange, extraction battle it out

In the Battle of the Colorado Plateau, where the forces of ion exchange are pitted against those of solvent extraction for recovery of uranium from leach liquors, it's getting more difficult to tell one side from the other.

The term "liquid ion exchange" has been coined to describe the mechanism of uranium extraction with selective solvents (*Chementator*, Dec. 1956, pp. 103–4). Now comes a new catch phrase, "solid solvent extraction," to confuse the issue further.

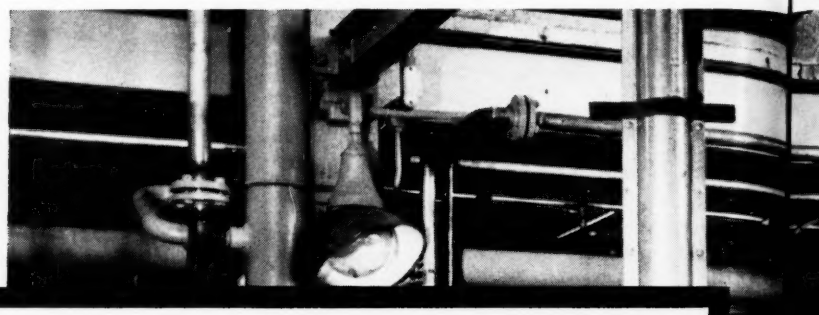
In this latest idea, worked out in the laboratory by Arthur D. Little, activated carbon loaded with adsorbed solvent (e.g., di-2-ethyl hexyl pyrophosphoric acid) is the extraction agent. Abrasion-resistant carbon particles (10–20 mesh) are mixed with the uranium-bearing liquor or pulp, then separated by simple screening, stripped of chemically bonded uranium with a back-solvent (e.g., aqueous soda ash solution) and recycled.

In other late chemical engineering maneuvers on the extraction side:

• Kerr-McGee, first to apply solvent extraction on plant scale to acid-leached uranium, cites highly favorable operating results.

• Bureau of Mines reports progress in

(Continued on page 144)



THE OLIVER HORIZONTAL FILTER

A standard unit in a job-engineered application at HOOKER ELECTROCHEMICAL

One of the most unusual and successful applications of the Oliver Horizontal Filter is at the Niagara Falls, N. Y. plant of Hooker Electrochemical Company.

This installation is unusual due to the highly specialized nature of the Hooker Process. The unit handles the dewatering, multi-component solution washing and final dewatering steps prior to thermal drying of HET Acid,* an ingredient of Hooker's flame resistant polyester resin Hetron*. Basically constructed of stainless steel all direct contact components are coated with a non-contaminable, corrosion-resistant plastic. Product conditions require that the filter hood be of a liquid seal-vapor-tight design providing a completely closed air return system. Control is automatic and viewing ports with illumination are provided for full visibility through the entire cycle.

The ability of the unit to provide sharp filtrate separations ideally suits the Oliver Horizontal Filter for solution washes when several filtrates must be kept separate. This feature along with many other facets of the versatility inherent in the Oliver Horizontal Filter, such as high capacity per unit area and multi-stage counter current wash, qualifies the standard unit for such highly specialized applications.

The Hooker Electrochemical installation is an excellent example of Dorr-Oliver ability to provide the equipment to fit the job. For further information on the Oliver Horizontal Filter, write to Dorr-Oliver Incorporated, Stamford, Conn. Ask for Bulletin No. 7201.

*T.M. Hooker Electrochemical Company

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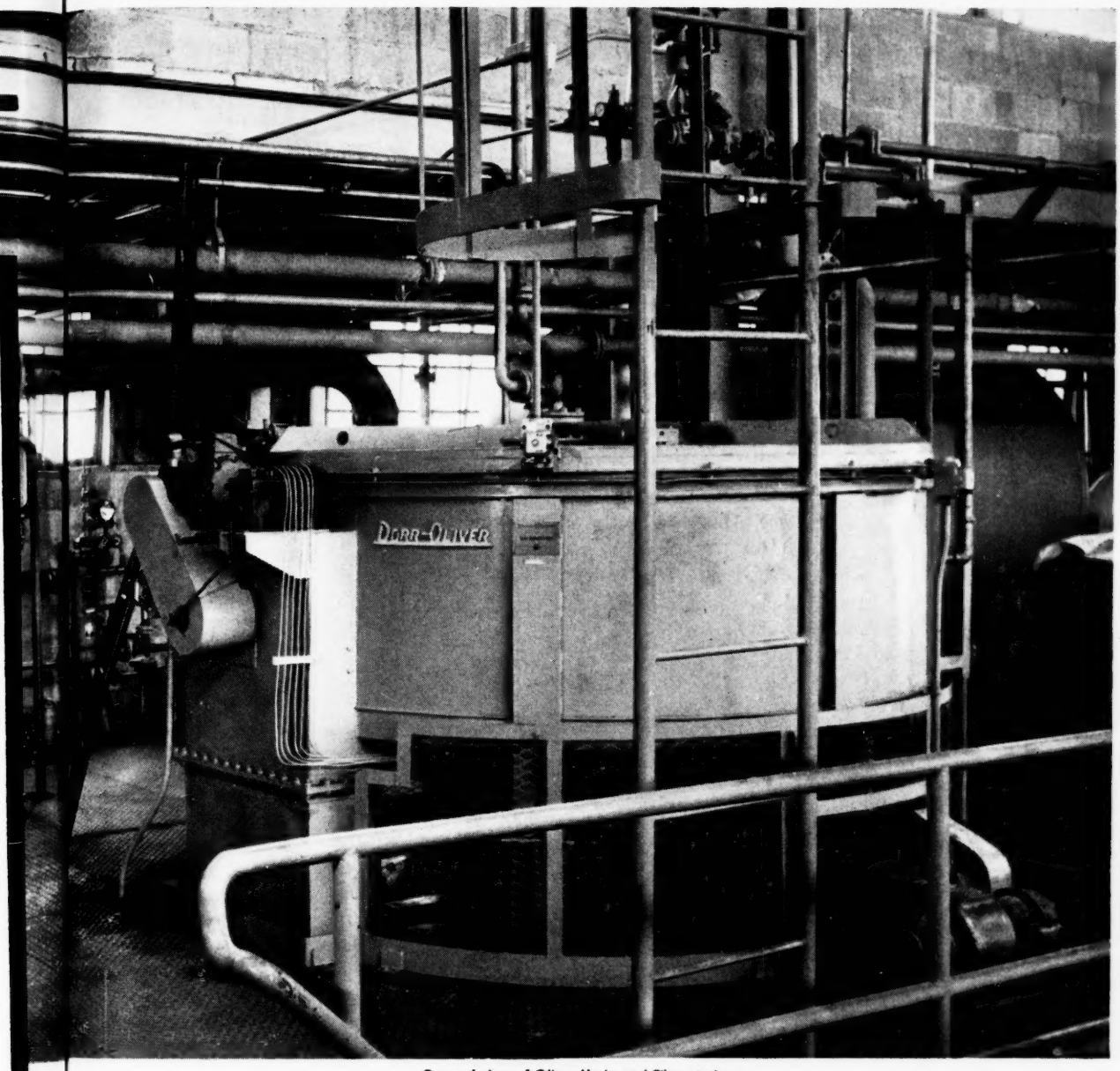
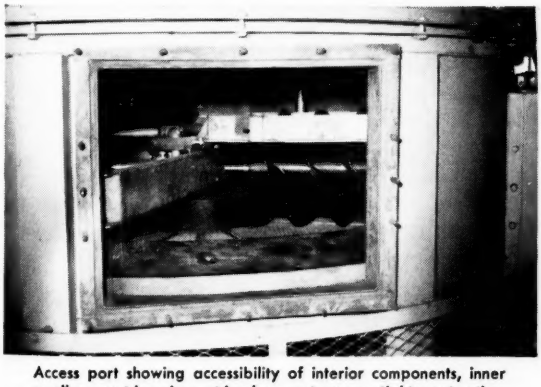
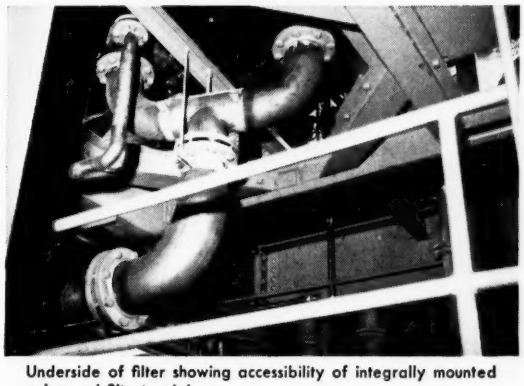


General view of Oliver Horizontal Filter station.



Access port showing accessibility of interior components, inner scroll support bearing not in place; note vapor-tight construction.



Underside of filter showing accessibility of integrally mounted valve and filtrate piping.

application of solvent extraction to pulps and slurries. Process works well on dilute pulps (less than 5% solids); chief problem with heavy pulps (40–60% solids) is high entrainment loss of valuable solvent. The Bureau is trying various contacting techniques to cut solvent loss, with encouraging results. Key idea is to add slurry to the solvent, rather than vice versa.

• In this same connection, Dow is looking for chemical additives that will minimize solvent loss. Most promising appear to be lignin sulfonates. Meanwhile, Dow is test-marketing Dowsol 12, a mono alkyl phosphate, which promises to be first of a line of solvents for the hydrometallurgical industry. Logic of such a move is borne out by Kerr-McGee's choice of solvent solely on the basis of commercial availability.

Over in the ion exchange camp:

• Anaconda, first to apply resin-in-pulp ion exchange, is enthusiastic about RIP's cost advantages over column ion exchange (*see* Process Flowsheet *next month*).

• Infilco and Techmanix have successfully pilot-planted the continuous counter-current ion exchange of uranium-bearing pulps. Process uses a machine similar to Infilco's Aero-Accelator. Simplicity of operation may help keep ion exchange on a favorable competitive basis with solvent extraction.

• Ionics and Oak Ridge National Laboratory are working on a new membrane development useful in uranium recovery.

Trend in high-vacuum equipment

Large-scale commercial use of low-micron pressures has taken a big jump forward in the past few months with development of six-stage steam-jet ejectors capable of pumping huge gas volumes at suction pressures as low as 2 microns Hg abs.

Graham Mfg. Co. has built two six-stage units and is now working on its third. Elliott Co. is building its second unit.

Capacity ratings range from 10,000 to 150,000 or more cfm., referred to 10 microns pressure. Low end of this range is set by the smallest practical size for the first-stage jet—the one discharging to atmospheric pressure—even though the sixth stage has a 48-in. suction inlet.

Graham and Elliott both cite such advantages of steam jets over mechanical pumps and oil-operated diffusion pumps as:

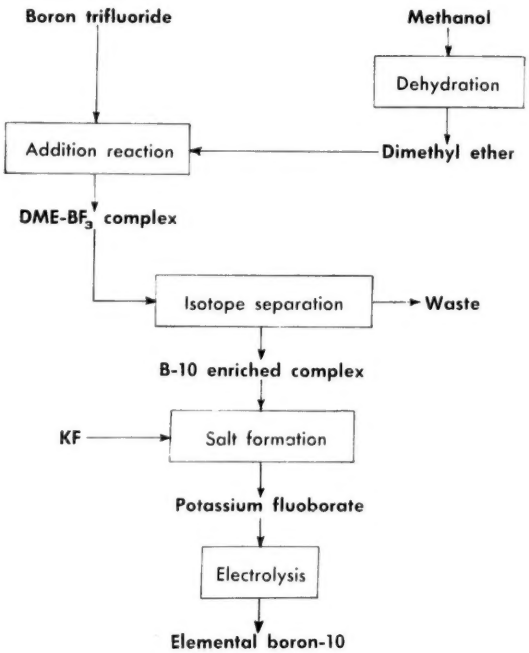
• Lower first cost, as low as one-fourth the cost of competitive equipment.

• Reasonable operating cost; a 12,000-cfm. unit uses only 600–800 lb./hr. of steam.

• Elimination of many maintenance problems.

• Higher capacities in the 2-25-micron range than have previously been commercially available.

Although current applications are in the field of vacuum metallurgy, uses of six-stage steam-jet ejectors in chemical processes are expected to materialize as present laboratory-size projects move to commercial status.



How and why AEC makes boron-10

Atomic Energy Commission in February lifted the veil of secrecy surrounding its production facilities at Model City, N. Y., revealing the above process for making the B-10 isotope of elemental boron.

Isotope separation—key step in process—uses a six-tower distillation train estimated by Hooker Electrochemical, contract operator of the plant, to provide 360 theoretical transfer units.

The $4-million plant turns out about 3

(Continued on page 146)

General Chemical Expands Nitric Acid Production

...Additional Capacity Now On Stream At Newell, Pa.

To supply growing demands for nitric acid by industrial and military users, General Chemical has made a major increase in the capacity of its large Newell, Pa., facilities.

These—together with the output of two other strategic plants—form the pipe line through which General provides the largest selection of grades and strengths of nitric acid on the market.

For over 50 years, General has been a leading producer of this basic chemical in all its forms . . . for every type of application. It pioneered the special fuming nitrics so important to the rocket program, and has a knowledge of the product and its properties invaluable to every user.

Whatever your nitric requirements may be—in metals or metallurgy, in engraving or explosives, in rockets or research—make General your source of supply. For carboys, carloads, tank cars and tank trucks, just call the nearest General Chemical office listed below.

AVAILABLE GRADES OF NITRIC ACID INCLUDE:

Standard & Diamond
36°, 38°, 40°, 42° Baume; 95-98%

Photo Engravers
36°, 38°, 40°, 42° Baume

Reagent, A. C. S.
Sp. Gr. 1.42

Red Fuming
Technical, Various Strengths of NO_2 content
Reagent, Sp. Gr. 1.59-1.60

White Fuming
Technical, 97.5% HNO_3
Reagent, A. C. S., Sp. Gr. 1.49-1.50

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lb./day of product, carrying an AEC price tag of about $1,500/lb. In making boron-10 available for commercial use, AEC hopes to stimulate new design concepts in nuclear reactor shielding and control. B-10 is a highly effective thermal neutron absorber.

Why more butyl rubber capacity?

Despite today's excess productive capacity for butyl rubber (installed capacity, 146,000 long tons/yr.; 1955 consumption, 78,000 tons), two firms are building new butyl plants: Petroleum Chemicals, Lake Charles, La. (30,000 tons/yr.) and Societe du Caoutchouc Butyl, Port Jerome, France (20,000 tons/yr.).

With the market for butyl rubber in inner tubes fast disappearing because of the tubeless tire, what accounts for this seemingly paradoxical situation?

Thiokol Chemical Corp., sales agent for Petroleum Chemicals, explains that butyl's nontransportation uses (conveyor belts, wire, hose, gaskets, etc.) are growing faster than any other segment of the synthetic rubber industry.

But more important is the coming of the all-butyl tubeless tire (*Chem. Eng.*, Jan. 1957, p. 142). Thiokol estimates that by 1960, 51,000 long tons/yr. of butyl rubber will be needed to manufacture these tires—if butyl tires are 10% of the 1960 passenger tire business, which might prove to be a conservative estimate. Prediction of total U. S. butyl rubber consumption during 1960 is 122,000 long tons, with export market pegged at 45,000 tons.

You can capitalize on Ti's strength

Titanium's desirable mechanical properties—largely overlooked heretofore by chemical engineers more interested in its corrosion resistance—are expected to open up major new applications of the metal in process equipment.

First fruits of this switch in emphasis are represented by two high-speed centrifuges just built by DeLaval Separator Co., in cooperation with Rem-Cru Titanium Inc., of a 6% Al, 4% V titanium alloy. With a yield strength of 120,000 psi. or more and a density only 56% of stainless steel, these experimental machines can run 28% faster for the same working stress in the rotating bowl. The machines are now undergoing thorough tests.

Meanwhile, Du Pont is spearheading a joint industry effort to get commercially pure titanium (55,000–70,000 psi. yield strength) incorporated into the ASME Unfired Pressure Vessel Code. Acceptance by ASME, observers feel, will put titanium in the same company, engineeringwise, as the better-established structural metals.

Chemical industry applications of titanium to date have generally used the same physical dimensions as would a similar item in stainless steel. Titanium's added strength has been considered merely as a fringe benefit. Designers have been hesitant to specify the lighter sections or thinner walls that greater mechanical strength and lower corrosion allowance might permit.

Key to Code acceptance and to more precise mechanical design is titanium's improving quality picture. As recently as two years ago, a fabricator might find wide variations in mechanical properties of a single lot of titanium sheet. How this situation is changing is exemplified by Mallory-Sharon's willingness today to guarantee mechanical properties of pure titanium within ±5,000 psi.

New look in electrolytic chlorine cells

Diamond Alkali's chlorine expansion at Deer Park, Tex., now under construction, represents a bold departure from convention in two regards:

- It will use 52 De Nora mercury cells, each rated at 120,000 amp.—far and away the largest cells in the chlorine-caustic industry.
- It will pioneer the large-scale use of germanium rectifiers. (see *Chem. Eng.*, Feb. 1956, pp. 126–8).

These two advances go hand in hand. Exploiting the advantages of large cells—fewer units to install, operate and maintain, less over-all floor space—had to await development of a rectifier which could efficiently supply large amperages of direct current in the needed low-voltage range.

Without the benefit of germanium rectifiers, an installation the size of Diamond's would probably use three times as many 40,000-amp. cells to get the over-all voltage drop across the line into the 600+-v. range served efficiently by mercury-arc rectifiers. Voltage drop across the 52 cells at Deer Park will be less than 250.

For more on DEVELOPMENTS.....148

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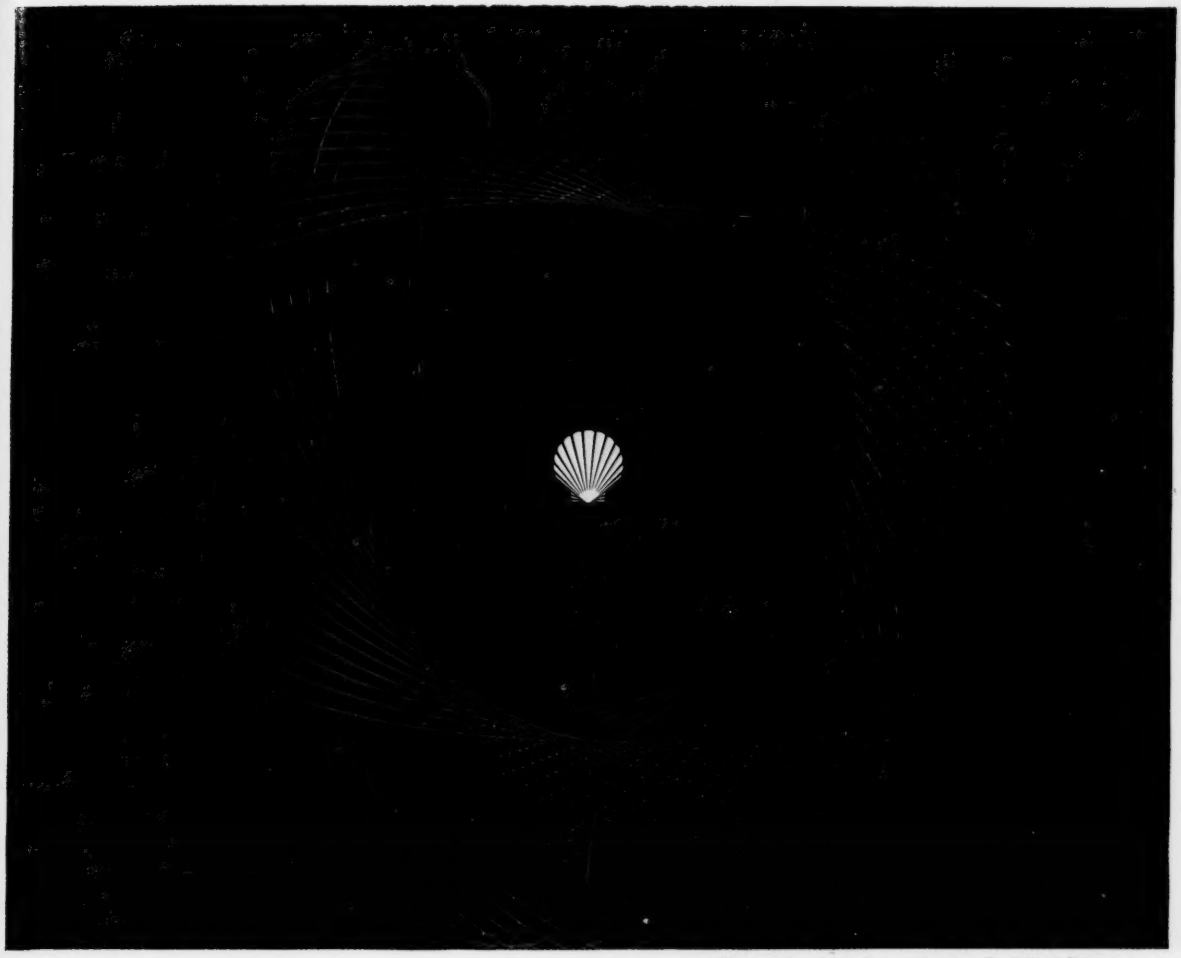

"Integration," an impression by C. Arthur Rosser

BUYING SOLVENTS?

Integrated deliveries reduce costs . . .

A GOOD WAY TO keep solvent costs down is to take full advantage of savings possible through *integrated deliveries*. When your total order equals a tank car quantity, you can buy individual solvents at bulk prices. Compartmented tank cars and tank trucks permit multi-product deliveries. Prompt delivery is assured from conveniently located storage facilities.

And when you make Shell Chemical your source for solvents, you can be sure that the products you receive will meet or exceed the highest purity standards set by industry.

Our technical service staff is prepared to work directly with you to help you make your own products better and less costly. Write for specifications and quotations on particular solvents.

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- Ethyl Amyl Ketone
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- Ethyl Alcohol
- Neosol© solvent
- Isopropyl Alcohol
- Methyl Isobutyl Carbinol
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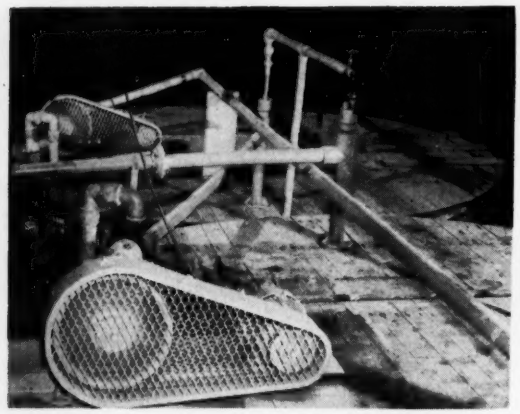
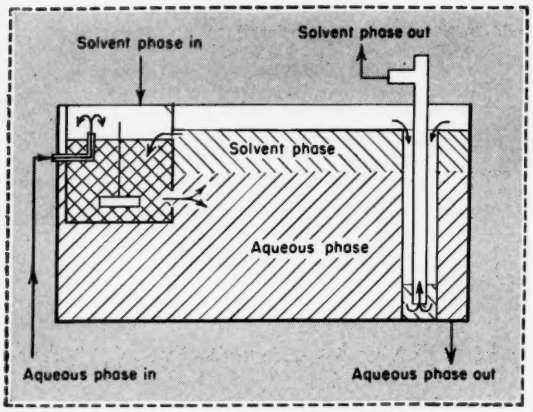
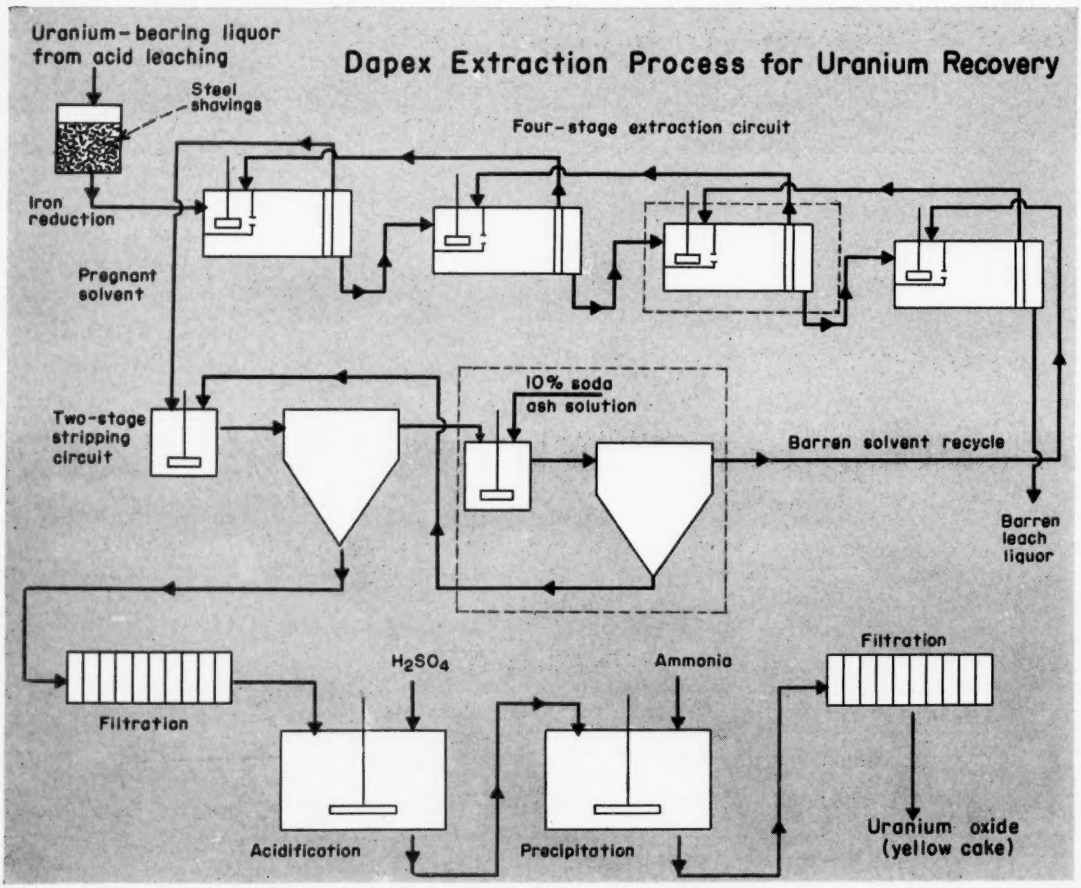
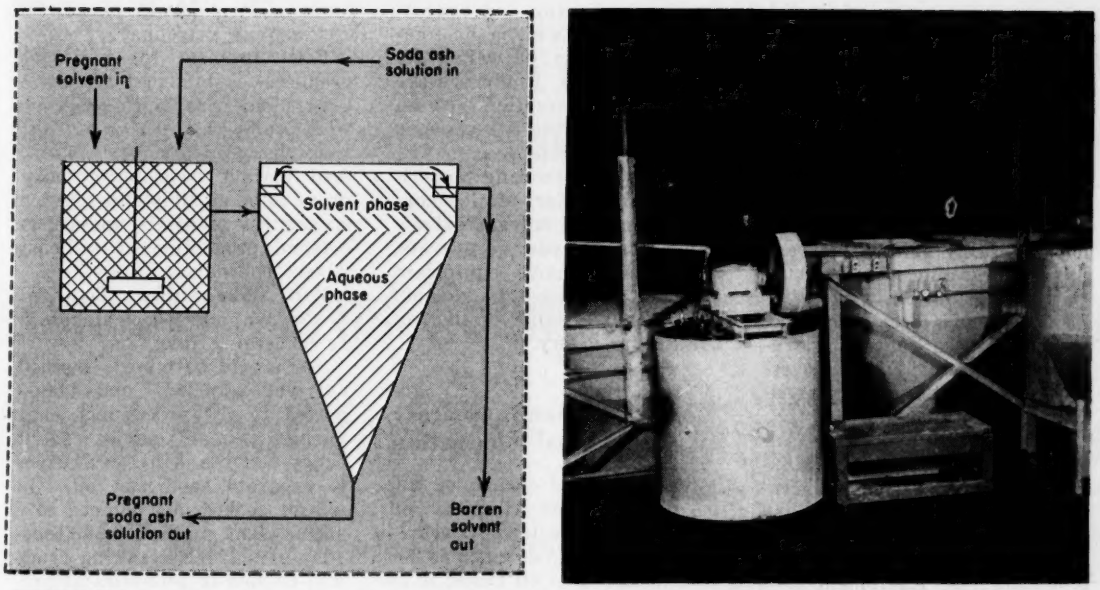




EXTRACTION occurs in novel mixer-settler; small agitated mixing tank sits inside large settling tank.





STRIPPING of uranium from solvent by soda ash solu tion takes place in this type of mixer-settler.

Now: Uranium via Solvent Extraction

Kerr-McGee is first to apply new process to sulfuric acid leach liquor; experience to date favors extraction over ion exchange.

URANIUM via solvent extraction of acid-leach liquor has now reached successful commercial operation.

Kerr-McGee Oil Industries, with its new continuous extraction unit on stream since September, released first details on equipment and operation late in February.* The Shiprock, N. M., unit reached design capacity within three days of startup and by now has treated over 15 million gal. of uranium-bearing liquor.

Although solvent (liquid-liquid) extraction has been used for a longer period by International Minerals for uranium recovery from wet-process phosphoric acid (*Chem. Eng.*, May 1956, pp. 130-132), Kerr-McGee is first to apply it to the sulfuric acid leaching process employed with Colorado Plateau uranium ores.

*At the New Orleans meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

▶Uses DAPEX Process—Kerr-McGee's extraction solvent is di-2-ethyl hexyl phosphoric acid and tributyl phosphate dissolved in a high-flash-point kerosene.

Choice of specific solvent involved consideration of dialkyl acid phosphates, monoalkyl acid phosphates and secondary amines. Compelling argument for picking the dialkyl (DAPEX) process was ready commercial availability of a good solvent. All other solvents, says Kerr-McGee, were potentially available only in experimental quantities.

As carrier for the solvent, Kerr-McGee chose a product of its own Deep Rock Oil Div., a kerosene with a flash point of 160 F. rather than the usual 110 F. This has helped reduce the fire hazard.

▶Vs. Ion Exchange—Kerr-McGee had been operating a uranium plant at Shiprock since December 1954, using column ion exchange for recovery of uranium from leach liquor.

Doubling of leaching facilities last year required an appropriate expansion in recovery capacity. Solvent extraction seemed to offer cost advantages over ion exchange, so company engineers seized this opportunity to explore its application. Pilot-plant tests convinced them that extraction would be more economical.

As a result, the company installed an extraction unit for treating 120 gpm. of acid liquor (from 350 tons/day of ore) at a cost approximately one-third that of an ion exchange unit of equivalent capacity.

▶Tank-in-Tank Extractors—Kerr-McGee's extraction battery uses a series of four unusual mixer-settler extractors (*see cuts, opposite page*).

Each stage consists of a wooden settling tank, 16 ft. dia. by 6 ft. high, and a 4-ft.-dia. by 4-ft.-high stainless steel mixing tank

mounted inside and against the wall of the larger settling tank. This arrangement eliminates piping between mixer and settler; connection is simply a hole in the mixer wall.

Mixer-settlers are in cascade arrangement, with 12 in. difference in elevation from one unit to the next. Aqueous phase flows by gravity. Solvent phase, traveling countercurrently, moves uphill via air lifts made of polyvinyl chloride pipe.

No interface control instruments are needed; a simple overflow weir system does an adequate level-control job.

▶ **Stripping, Precipitation**—Solvent phase from the fourth extraction stage yields its uranium content to a 10% soda ash solution in a two-stage, countercurrent back-extraction (stripping) process. Equipment used here is more conventional—4-ft. by 4-ft. steel mixers and 8-ft.-dia. cone-bottom steel settlers. Cone bottoms are needed to handle hydroxides of titanium and iron which may precipitate from the solvent.

Carbonate liquor from the stripping step, containing as much as 70 grams/liter U_3O_8, goes to a precipitator, where the carbonate is destroyed by addition of acid and the uranium precipitated with ammonia.

▶ **Operating Experience**—The extraction process has run for extended periods with better than 99.7% recovery of uranium. One operator per shift looks after both extraction and stripping.

Solvent loss has been 0.5 gal./1,000 gal. of aqueous liquor treated, at least half of which is due to mechanical entrainment in the raffinate. Kerr-McGee engineers are studying possible ways to reduce this loss, such as using a trap tank or by operating the mixers with the solvent as continuous phase.

▶ **Plus Ion Exchange**—With the original ion exchange process also in operation, Kerr-McGee has been mixing the acidic ion exchange effluent with the extraction process's alkaline effluent to save on reagent acid, precipitating the uranium oxide product from the mixed solution.

This arrangement has produced complications in operating procedures which, the company feels, may outweigh the reagent savings. Engineers are reviewing the situation with an eye to treating the two streams entirely independently.

Based on operating experience to date, Kerr-McGee concludes that the solvent extraction process is easy to operate, uses less-expensive equipment and is competitive in reagent cost with any other method of uranium recovery.

Alberta Oil Sands Nearer To Commercial Production

Soon a raft of companies will be exploiting the Athabasca oil sands in northeastern Alberta—estimated to hold as much as 300 billion barrels of oil locked in as bituminous sands.

Among the furthest along in planning at this time are Royalite Oil Co. of Calgary, Alberta, and its associates, with a $50-million commercial development program scheduled for completion in 1960.

▶ **New Process Is Key**—Royalite, along with Can-Amera Oil Sands Development Co. (which owns the patents), has worked for two years perfecting the Coulson centrifuge process (*Chem. Eng.*, June 1955, pp. 130-2) to spin oil from the sand. Royalite recently bared plans for constructing a separation plant and a 20,000-bbl./day processing plant on its 50,000-acre lease at Mildred Lake.

Exact process details are still under wraps. It's believed that the process entails diluting oil sand with a light oil to lower specific gravity and make it flow, then feeding mixture to separators. Oil sand and diluent are thrown centrifugally through a constant layer of water and chemicals (to improve wetting), and oil, sand and clays separate by differences in densities. Method gives an emulsion-free oil.

▶ **Other Firms Interested**—Other companies with holdings in the area include: Shell Oil Co., Union Oil of Calif., Sun, Richfield, Canadian Pipelines, Great Canadian Oil Sands and a group of companies headed by Calvan Consolidated (subsidiary of Canadian Petrofina).

First problem for potential producers is to ferret out markets. Some are now busily at work cultivating markets outside the province of Alberta. And market development may prove to be no simple task, since economical oil-sands operations demand production of at least 20,000 bbl./day.

▶ **Will Make Sulfur, Too**—Oil production and processing will be something like this:

Sands will be mined (method not yet revealed) and transported to the processing plant (using as many as 50 centrifuges) on the Athabasca River to separate sand and oil. Oil will be cooked and pumped to a sulfur plant, producing 140 tons/day of sulfur. Resulting crude will be sold to refineries at premium price over natural crude, since it's expected to yield more high-value products.

Oil isn't the only potential product locked in Alberta's oil sands. Waste sand makes excellent raw material for glass and contains about 20 different minerals, including vanadium. In addition to oil, there's a hint of hope for a rare-metal industry along the Athabasca River.

Ethylene Glycol, Butyl Rubber Boom in South

Total of $28 million will be spent by Calcasieu Chemical Corp. and Petroleum Chemicals, Inc., for chemical plant construction in the Lake Charles, La., area.

Calcasieu will own an $11-million, 8-million-gal./yr. ethylene glycol plant, to be built by Petroleum Chemicals. Plant, to be on stream in early 1958, will produce intermediate ethylene oxide via the Shell ethylene oxidation process. Process involves fixed-bed oxidation over a promoted silver catalyst.

Petroleum Chemicals will construct its own butyl rubber plant—costing over $17 million—at Lake Charles. The 30,000-ton/yr. plant is scheduled to be on stream in January 1959 and will use process licensed from Jersey Standard. Plant capacity can be expanded at a later date.

LUMMUS

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Lummus Turns Roundhouse into Beryllium Metal Plant for The Beryllium Corporation

$4,000,000 project to be completed by August 1957

On September 6, 1956 Lummus began initial process engineering and design of a $4,000,000 plant to extract beryllium metal from beryl ore. Scheduled to start operation on August 6, the new plant over the next five years will produce 500,000 pounds of the light metal — all contracted for by the A.E.C. Beryllium is used extensively in atomic reactors where it is an excellent moderator and neutron reflector, because of the small mass of its nucleus and its low affinity for slow neutrons.

Last year The Beryllium Corporation acquired a 2000-acre tract of land at Ashmore, Pa., including some old railroad buildings. The company called on Lummus, to design and construct the beryllium metal plant in the locomotive roundhouse.

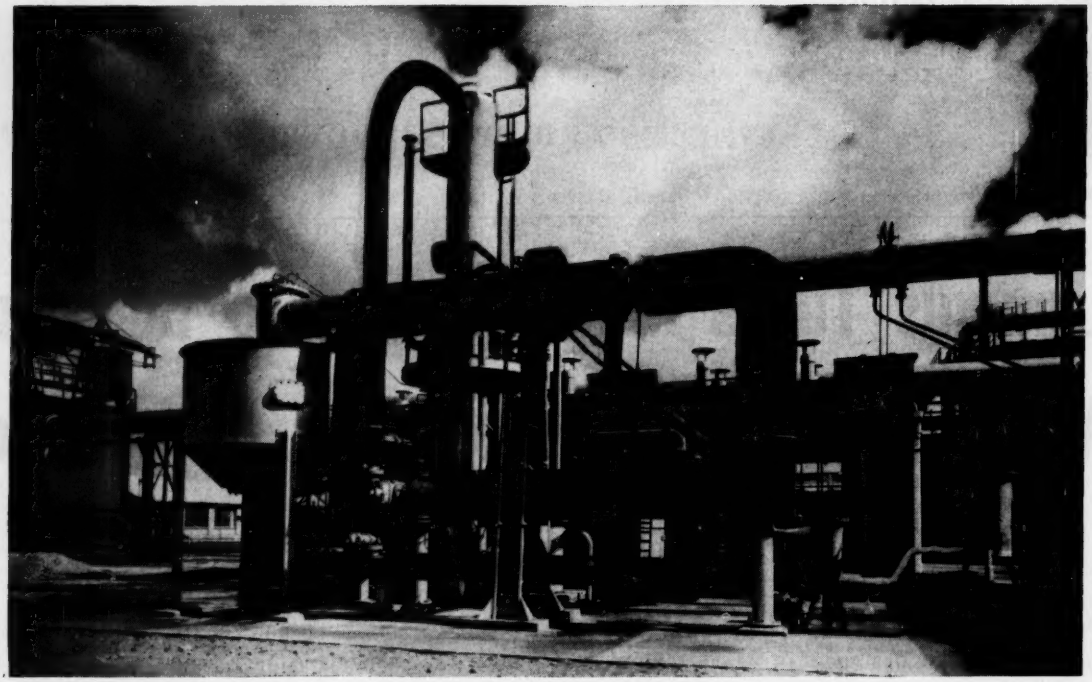
The Lummus design accomplishes the extraction of beryllium metal from its ore — while giving prime consideration to the health and safety of plant operators.

The ability to meet difficult and unusual design, engineering and construction requirements is one reason why more and more metals and chemical producers are engaging The Lummus Company to handle their new plant projects.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y. Engineering and Sales Offices and Subsidiaries: Houston, Montreal, London, Paris, The Hague, Bombay. Sales Offices: Chicago, Caracas. Heat Exchanger Plant: Honesdale, Pa. Engineering Center: Newark, N. J.

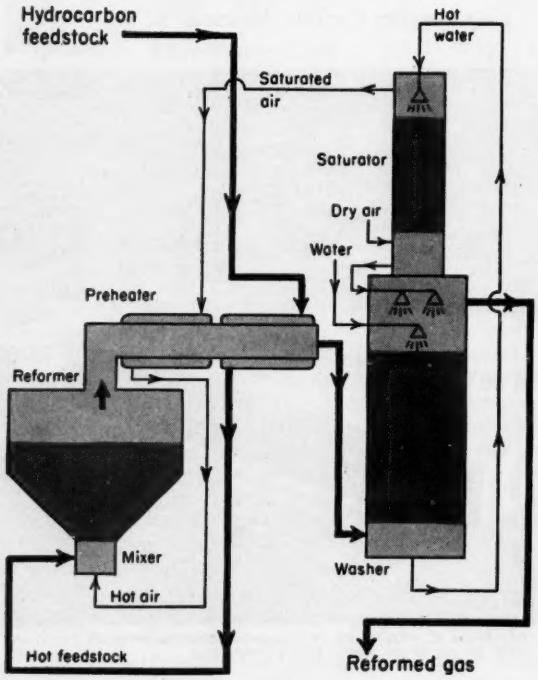
Old locomotive roundhouse at Ashmore, Pa., will soon be producing beryllium metal for use by the Atomic Energy Commission

Chemical Progress Week — April 8-12



CATALYTIC autothermic reformer combines desirable design and operating features in a novel way.

This Reforming Process Is Different



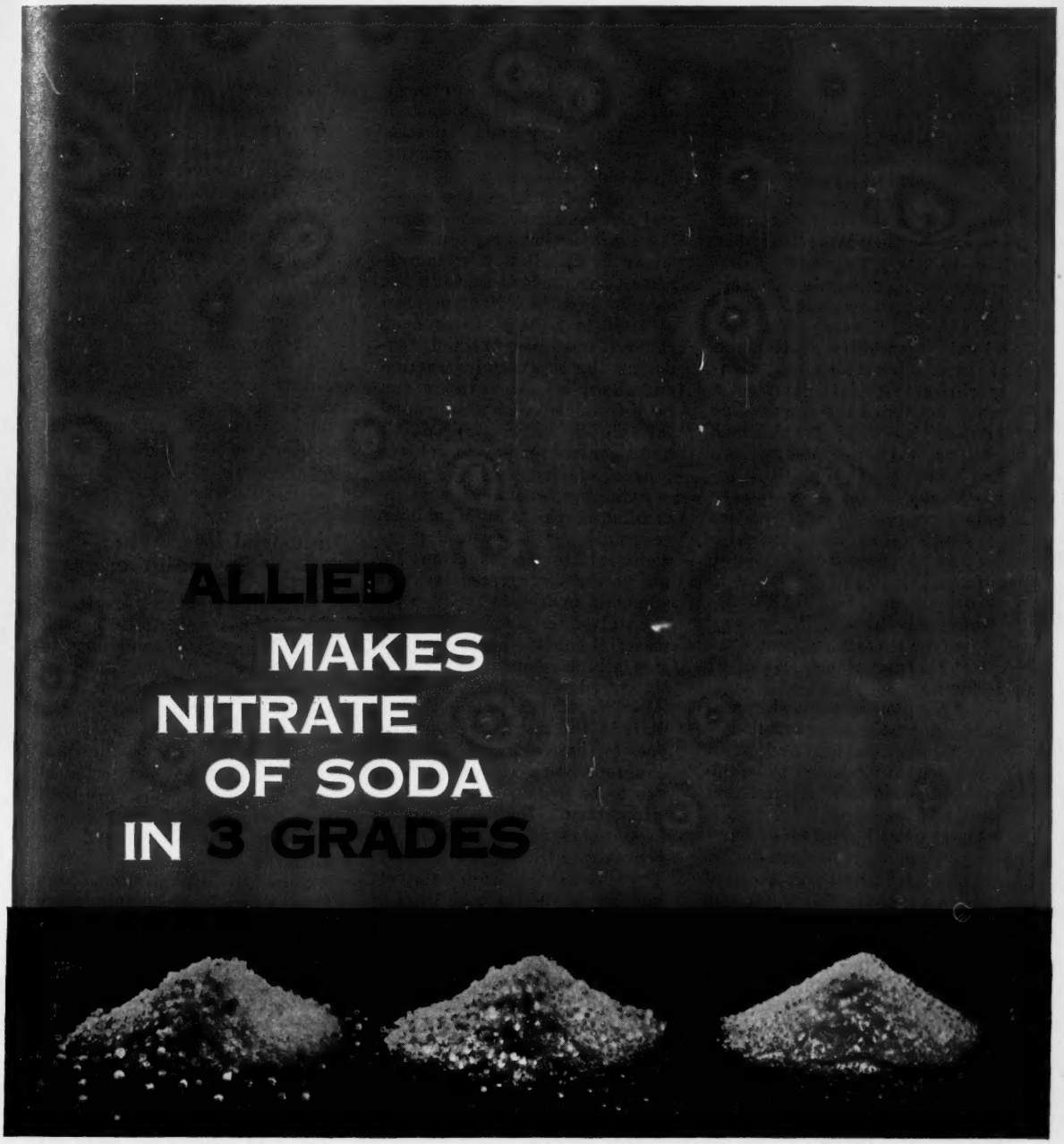
- **Uses single bed of catalyst.**
- **Requires no external heat source.**
- **Operates continuously.**
- **Requires no oxygen supply.**

A hydrocarbon reforming process, developed recently in Europe and now available in this country, produces a hydrogen-rich fuel gas or a synthesis gas by continuous autothermic catalysis.

Unlike most other catalytic reforming processes, it does not require an externally fired, tubular converter; its converter is simply an insulated vessel containing a single bed of catalyst, operating at 1,400-1,600 F.

Unlike most thermal reforming processes in the manufactured gas industry, it operates continuously, not cyclically. And it bypasses the need for an oxygen supply, characteristic of partial oxidation processes for hydrogen.

▶**Proved Commercially**—Process has been in commercial use since 1953 in Belgium. There are now five operating plants, plus one being built. Three are for fuel gas and three for ammonia synthesis gas. (*Continued*)



. . . to save you processing and handling costs

If you use nitrate of soda, Arcadian Brand offers you an important extra at no extra cost: your choice of three crystal sizes—coarse (1-C), medium (2-B) and fine (3-A). With three grades to choose from, you select the one that suits your operation, thus save on special processing and handling. Only Allied's Arcadian Brand gives you this advantage.

Another Arcadian Brand plus—solid crystals that do not crush or create fines in handling. Finally, Arcadian is 99.50% pure.

Arcadian Brand is shipped from Hopewell, Va. in bulk and in 100-lb. moisture-proof multiwall bags. Write for samples, prices, literature or technical service.

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Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

For license in this country through Gas Machinery Co., Cleveland, the process is called continuous catalytic autothermic reforming (CAR). The Cleveland firm has acquired licensing rights from European co-owners, Societe de Distribution du Gaz du Brussels (Belgium) and Compagnie Generale de Construction de Fours (Montrouge, France).

▶ **Fuel Flexibility**—CAR can produce high-hydrogen, high-specific-gravity fuel gas from a range of hydrocarbon gases or liquids. To meet peak loads, low-Btu. CAR product gas can be mixed with high-Btu. refinery gas, propane or butane to bring burning characteristics of sendout gas into line with specific requirements.

In addition to flexibility as to feed and product, CAR's advantages include:

- Low investment cost.
- Thermal efficiencies of 97 to 99%.
- Simple, continuous operation, adaptable to automation.
- Quick startup and shutdown without damage to equipment, needed for intermittent demands.

▶ **Operating Experience**—First major commercial installation was that of Distrigaz at Mont St. Aldegonde, Belgium, in 1953. Committed to recover about 9 million cu. ft./day of methane from Belgian coal mines, the company CAR-reforms it into 180-190-Btu./cu ft. product. This is enriched to 478 Btu./cu. ft. by mixing with more methane or with propane-butane.

Illustrating CAR flexibility, another Distrigaz installation solves two different problems at a coke-oven plant in Grimbergen, Belgium. During the summer, it reforms part of an over-rich sendout gas of 25% methane for dilution—formerly accomplished by mixing spent flue gases to hold a specified calorific value; during the winter, it produces additional reformed gas from propane or butane to meet peak load requirements.

For ammonia synthesis, Distrigaz has CAR installations at Tertre and Selzaete, and one upcoming at Tilleur, Belgium.

▶ **Heart of Process**—Key piece of equipment in a CAR system is a refractory-lined, conical-bottom reformer partially filled with catalyst.

Preheated hydrocarbon gases and process air are fed in regulated proportion to a diffuser-mixer, or distributor, which directs them upward through the catalyst bed. Reactions proceed at 1,400 to 1,600 F. to produce raw reformed gas. Without rendering the exothermic reaction endothermic, water vapor can be introduced with the incoming air to increase product's hydrogen content or to achieve process efficiencies.

After heat exchange with incoming stocks and scrubbing. reformed gas is ready for enrichment to specification for utility use or for feedstock for ammonia synthesis.

Catalyst is an impregnated material containing free nickel, specially developed for high activity. high temperature and long life. It can be modified to fit both the nature of the rich gas to be reformed and the characteristics of the reformed gas to be produced.

▶ **Important Details**—Process owes some of its current advantages to Distrigaz engineers. They improved the catalyst; introduced limited quantities of steam into the process air feed to better control the reaction, to increase its efficiency, to build up hydrogen content of the resultant gas and to avoid deposition of carbon black in the catalyst bed.

A patented contribution of Compagnie Generale de Construction de Fours is the diffuser-mixer with which all units now come equipped. It helps to distribute feedstock evenly over the entire catalyst bed and diminishes the risk of carbon formation. It prevents flashback when high-hydrogen feedstocks are used.

Regional Group Will Battle Air Pollution

A new regional organization embracing California, Oregon, Washington, Montana, Idaho, Nevada, Arizona, Utah, New Mexico, British Columbia and Baja, Lower California, will fight atmospheric pollution.

Organized as the West Coast Section of the International Air Pollution Control Assn., the group will promote interchange of data regarding air-pollution problems and techniques of control between government officials, research agencies, universities and private industry.

S. Smith Griswold, chairman of the new group, emphasized that the new section was organized to aid in developing and administering programs to control increasing air-pollution problems in the western U. S., Canada and Mexico.

Industrial Research To Get Streamlining

Esso Research and Engineering Co. has set up a special technical information division to speed its scientific work and conserve technical manpower.

The new division will include a corps of specialists to streamline the work of gathering, evaluating and channeling technical information to scientists in both Esso Research and other Jersey Standard affiliates around the world.

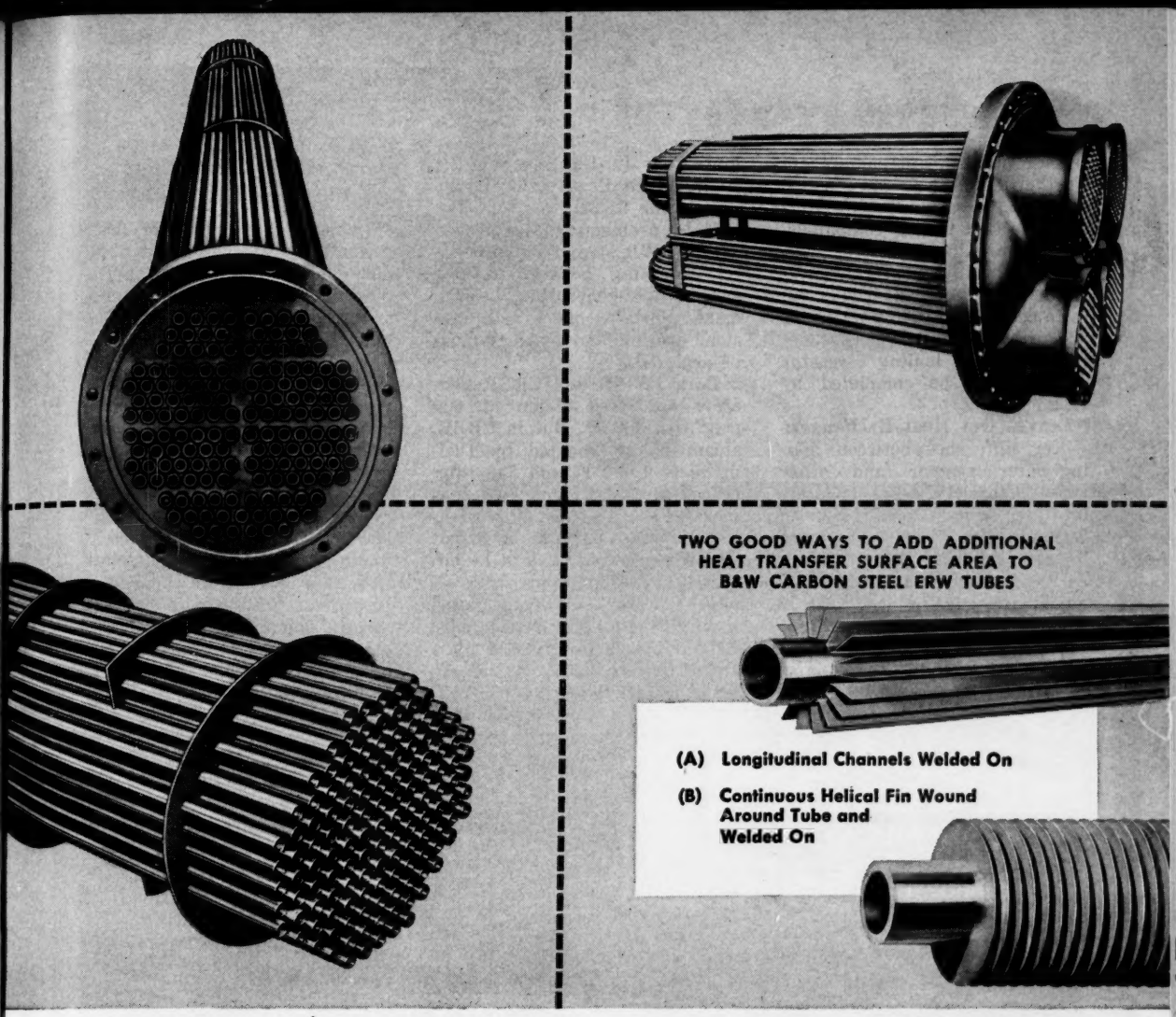
Such an organization, says Esso, will fill a real need, since the volume of technical literature in the U. S. has been more than doubling every ten years.

Boiling Water Reactors Slated for Power Uses

A new breed of nuclear power reactor—the boiling-water reactor—will result from tests now under way at Argonne National Laboratory's new 5,000-kw. atomic power station. Four boiling-water reactors, based partly on these tests, are now projected or under construction.

ANL's 20-mw. (heat) experimental boiling-water reactor (EBWR), first critical in December, began generating power early this year in order to give engineers information for future use in large-scale atomic power station design.

Most recent announcement of a commercial-scale boiling-water-


TWO GOOD WAYS TO ADD ADDITIONAL
HEAT TRANSFER SURFACE AREA TO
B&W CARBON STEEL ERW TUBES
(A) Longitudinal Channels Welded On
(B) Continuous Helical Fin Wound
Around Tube and
Welded On

TUBING REQUIREMENTS FOR HEAT TRANSFER EQUIPMENT

The economy and usefulness of pressure tubing in heat exchanger and condenser applications depend on the tubing's heat transfer ability and the ease with which it can be bent, coiled, swaged, and rolled into tube sheets.

Because of its uniform wall thickness, the heat transfer ability of B&W Electric-Resistance-Welded Carbon Steel Tubing is the optimum for such a ferrous material. It is an economical material to use, not only because of its reasonable first cost, but also because of its low fabrication cost, since ease of bending, coiling, swaging, and rolling into tube sheets is provided through quality-controlled methods used in its manufacture.

B&W Electric-Resistance-Welded Carbon Steel Heat Exchanger and Condenser Tubing is widely used in the process industries, including petroleum refining and chemical processing, and in refrigeration and steam generating equipment. If carbon steel tubing can do the job required, you will find B&W ERW Tubing provides maximum, trouble-free service life. For additional information, call on Mr. Tubes, your nearby B&W Tube Representative — *or write for Bulletin 412.* The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy, and stainless steels

reactor power plant came from Northern States Power Co., one of a group of participating Midwest electric utility companies, and from Allis-Chalmers Mfg. Co., which will build all power-generating equipment. Plans call for a 60,000-kw. (133 mw. heat), $20- to $25-million controlled-recirculation boiling reactor (CRBR), to be completed by 1962.

▶ **Leaves Out Heat Exchangers**—Key difference between boiling-water reactor and other types is that BWR has no intermediate heat exchangers to transfer heat from reactor core to water boilers. Water, acting as moderator and coolant, is boiled directly in the reactor core, and the steam goes right into a turbogenerator. After condensation, water recirculates through the core—by natural convection in the case of the EBWR, forced convection in the case of the CRBR.

Main problems to be probed with EBWR stem from this direct coupling between reactor and power-generating equipment. Such problems as corrosion, erosion and leakage must be explored.

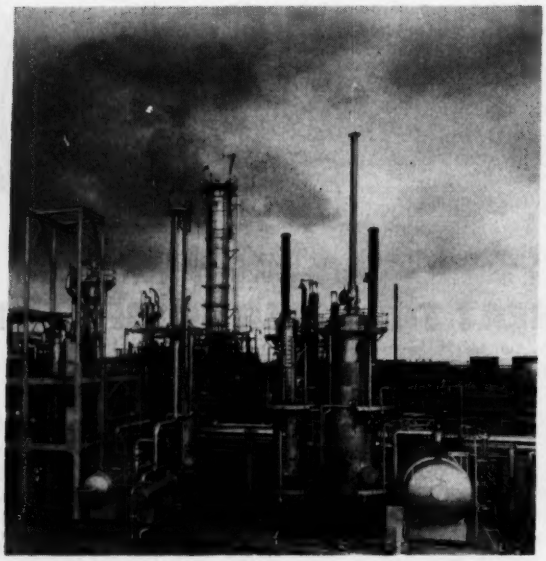
Both EBWR and CRBR generate saturated steam at 600 psig. and 488 F. But in CRBR, steam is superheated by fuel-firing to 1,000 F. and 540 psig. before entering turbine, whereas in EBWR, saturated steam enters turbine through a dryer. CRBR power output will be adjusted by controlling rate at which water is recirculated through the core by large pumps. EBWR power is adjusted by a steam bypass valve between reactor and turbine.

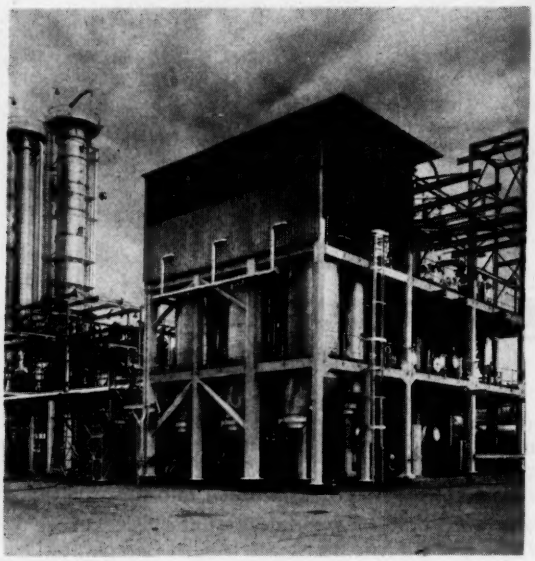
Rare Alkali Chemicals On the Way to Market

Immediate market for San Antonio Chemical's new plant to make mixed alkali salts of potassium, rubidium and cesium—on stream last month—will be glass and ceramics industries.

Process (*Chem. Eng.*, Jan. 1957, p. 107) will use end liquors from American Lithium Chemicals' lithium hydroxide operations. It involves clarification, granulation and dehydration of salts in these liquors.

Combined research and market development will be aimed at finding practical ways to isolate rubidium and cesium carbonates and reduce these salts to pure metals, plus developing commercial uses for the pure metals once process problems have been solved.





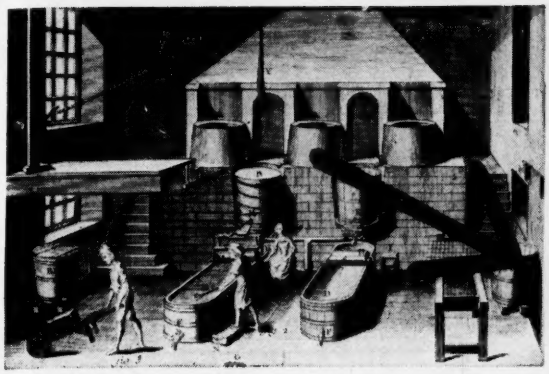
Close Process Control Means High-Quality Alkylate

New detergent alkylate plant at Shell Chemical Co., Ltd.'s Shell Haven refinery in Essex will help meet rising alkylate demand without aggravating England's acute dollar shortage.

Plant uses up-to-date techniques to make high-grade alkyl benzene (principal raw material for syndets) at a rate of 28,000 tons/yr. Shell will export about 13,000 tons and will use some for its own syndets, including a newly acquired nonionic line.

Process involves mixing benzene with suitable olefins in acid-catalyst reactor, separating and recycling catalyst to reactor and distilling pure alkylate.

Picture at left shows (l. to r.) scrubbing unit, distillation towers, acid-catalyst unit; right-hand picture shows dryers and treaters.



Important new things are happening to waxes

Wax, almost as old as civilization itself, is now being remarkably upgraded and improved by combining it with the newest of polymers, A-C POLYETHYLENE. This low-molecular-weight, low-viscosity polyethylene easily and economically up-grades both paraffin and microcrystalline waxes, replaces costly vegetable waxes.

Because A-C POLYETHYLENE handles as easily as wax, there's no need to change processing methods... you can blend it on all conventional equipment whether for hot melt or emulsification processes. And, A-C POLYETHYLENE is low in cost, uniform in supply and quality.

Added to waxes, A-C Polyethylene improves:

blocking	gloss	scuff resistance
color intensity	hardness	water resistance
coverage	mileage	tensile strength

Further, A-C Polyethylene helps:

- decrease slip
- reduce bulging and leaking in dairy cartons
- aid weatherproofness of building materials
- protect yarns and fibers in textiles and paper

Check this list for industry-proved applications of A-C Polyethylene; then investigate its advantages in your formulations:

Asbestos shingles	Leather
Bottle cap liners	Linoleum
Boxboard containers	Metal powder lubricants
Candles	Paints, lacquers and varnishes
Carbon paper	
Color dispersants	Paper, coating, laminating and sizing
Cosmetics	
Crayons	Pharmaceuticals
Dairy cartons	Plastics
Fibre drums and cups	Polishes, liquid and paste
Fruit and vegetable coatings	Potting compounds
	Printing ink
Glass bottle coatings	Textile size
Industrial coatings	Tile, asphalt, cork and rubber
Insecticide spray	Wax blending
Investment waxes	Wire and cable

Write on your letterhead advising us of intended use. We will send you data sheets and samples of the appropriate grades of A-C POLYETHYLENE.

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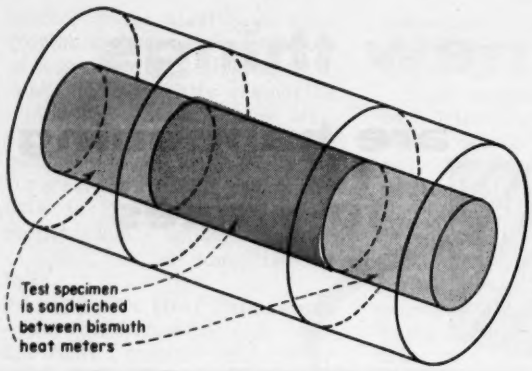
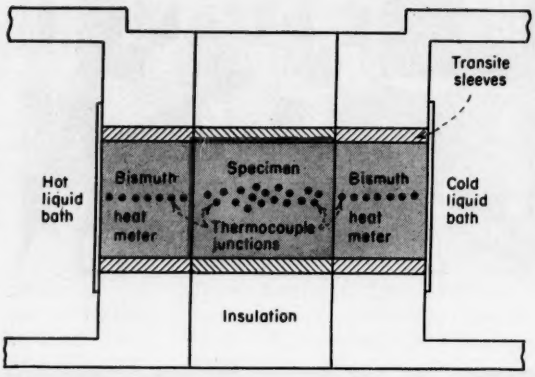
Allied Chemical

*Trade-mark





Measure Conductivity This Better Way

New steady-state technique uses "heat meters" of pure bismuth to measure heat flow through porous materials, sidesteps drawbacks of conventional techniques.

From the stretches of Texas comes a recent advance in measuring thermal conductivity which promises to capture attention of a lot of engineers.

Potentialities of this new steady-state method are as yet virtually untapped. Technique perfected at Texas Engineering Experimental Station, College Station, Tex., is now being used to measure thermal conductivities of soils. But the simple method may be applied to other kinds of porous solids.

▶ **Uses Bismuth Heat Meters**—Key to the new method lies in two bismuth "heat meters" (*see cuts*) which measure rate of heat flow through the specimen under test at steady-state conditions. Knowing the temperature gradient across each of two solid, pure bismuth cylinders on either side of the test specimen makes it easy to determine directly and accurately the average heat flux along the test specimen.

Other, more widely used, unsteady-state techniques measure total heat energy put into the specimen in a certain time and demand elaborate precautions to measure or prevent heat loss.

▶ **Long-Horn Dilemma** — TEES engineers had tried—with little success—two recognized unsteady-state methods for measuring thermal conductivities of soils. They were gathering data for design of buried coils, a phase of TEES's research program on heat pumps.

One method required observing the change in specimen temperature gradient with time; the other, immersing a soil specimen into a constant-temperature bath and measuring temperature pattern at the center of the sample until it reached equilibrium.

Neither method gave satisfactory results. Biggest trouble was poor reproducibility. Too, both tests failed to take into account the phenomenon of thermal moisture migration—moisture moving from higher-temperature to lower-temperature zones in the sample.

▶ **Steady-State Does Job**—Then Project Engineers D. M. Vestal and B. J. Fluker came up with the steady-state heat-meter method.

The cylindrical test sample, with 22 copper-constantan thermocouples along its axis and encased in a Transite sleeve, is sandwiched between two bismuth cylinders—also in Transite sleeves—and the three pieces placed between hot and cold constant-temperature baths.

Bismuth meters are easily prepared in the lab (melting point of Bi is 520 F., compared to 621 F. for lead) and thermal conductivity of bismuth as a function of temperature is accurately known. Thirty-five thermocouples embedded in each bismuth cylinder indicate temperature gradient along its axis.

▶ **Basic Principles** — Knowing conductivity k, length L and cross-sectional area A of the meters, it's easy to get equilibrium rate of heat flow through each of them from the simple heat-conduction formula:

$$q = kA\Delta T/L$$

where ΔT is the observed temperature gradient across each meter and q is rate of heat flow in Btu./hr.

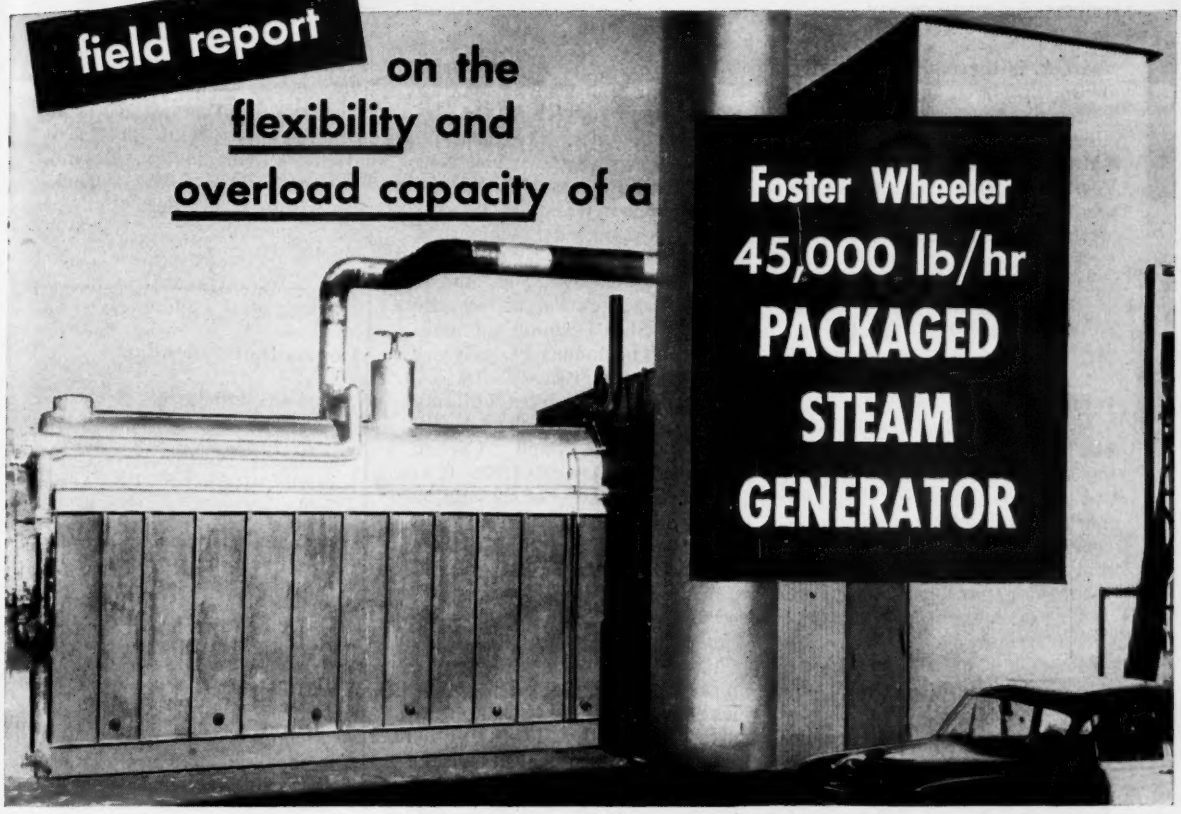
When rates of heat flow measured by both meters at the time of specimen steady state (after 150-400 hr.*) differ by 5% or less, Vestal and Fluker assume, the average of the two rates is the heat flow through the test specimen.

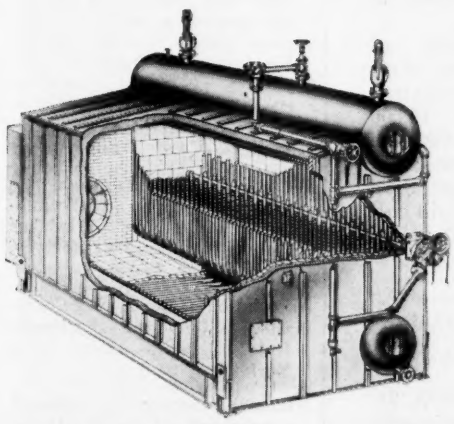
From this q_{avg}, thermal conductivity of the specimen can be calculated by:

$$k_s = q_{avg}/(dT/dL)_s$$

*Extended period is required to reestablish moisture equilibrium by thermal moisture migration. Shorter times suffice for unsteady-state methods.

field report on the flexibility and overload capacity of a Foster Wheeler 45,000 lb/hr PACKAGED STEAM GENERATOR





Cutaway drawing of FW Packaged Steam Generator of the type shown installed above at a large New England chemical plant. Except for the firing front, the entire unit is located out of doors. The performance tests mentioned here were made in December, under typical New England weather conditions.

FOSTER WHEELER engineers have conducted extensive performance tests on a 45,000 lb/hr oil-fired Packaged Steam Generator installed at a large New England chemical plant.

During a 30-day period, the unit was operated at 42,500 lb/hr on a 24-hour basis, delivering over 1,000,000 lb of steam per day. It was also operated at 46,500 lb/hr over an 8 hr period.

Efficiency at design load of 45,000 lb/hr exceeded contract requirements of 83.2%. During performance tests the boiler was operated in excess of 51,000 lb/hr at an efficiency of 82%.

Although purchased as a base load unit, tests were also conducted to determine its flexibility. Rapid load swings from 10,000 to 51,000 lb/hr were set up while on automatic control. The boiler was able to swing from one extreme to the other in considerably less than 60 seconds.

This very satisfactory performance stems from the conservative FW design and generous water storage capacity which are important features of the entire standard line. Available in rated capacities from 10,000 to 50,000 lb/hr, with wide choice of burners and controls. For complete information, send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

where k, is thermal conductivity of the specimen and (dT/dL), is temperature gradient at a point in the specimen.

▶ **Method Reaps Advantages**—Vestal and Fluker cite these advantages for the heat-meter method over unsteady-state methods:

- Gives better reproducibility.
- Takes into account thermal moisture migration—a big factor in solids.
- Gives several conductivity values per run.

Intead of being a stumbling block—as in unsteady-state methods—moisture migration is put to good use in the new method. After the specimen has reached steady state (both heat and moisture), it is removed from the apparatus, pressed out of the Transite sleeve and "cut down" from one end to locate exactly each thermocouple with respect to an arbitrary but constant coordinate system. Thirteen samples for moisture determination are taken at intervals along the specimen. Enough weights and dimensions are recorded for five separate density determinations.

Moisture gradient—caused by moisture migration in the sample—thus gives the investigator an opportunity to get samples of different moisture contents from the same test specimen.

▶ **Correlation of Data**—Vestal and Fluker correlate data with soil properties: specific gravity, dry density, moisture content, liquid limit and plastic limit.

TEES engineers have tested 18 soils by this heat-meter method and have used the data in designing buried-coil heat-pump installations in the Fort Worth area. It's a good bet that the heat-meter method won't be too long in transition from soil research to a widely used engineering tool.

Expansions Slated for Polyethylene, Irrathene

Spate of new plants and expansions will boost output of polyethylene in the U. S., Brazil and Germany.

In U. S.:

- General Electric Co. is swinging into full-scale production of Irrathene at Pittsfield, Mass., and will soon be making 1.6 million lb./yr. of the irradiated polymer. To irradiate, GE is setting up five electron-beam generators at Pittsfield.
- Spencer Chemical Co. recently announced commercial production of high-density polyethylene at Orange, Tex., and is building a new plant on the Houston Ship Channel for making the high-density polymer (low-pressure process).
- Other companies building low-pressure polyethylene facilities: Carbide and Carbon Chemicals Co. at Seadrift, Tex., Grace Chemical Co. at Baton Rouge, La., Celanese Corp. at Houston.

Industrias Quimicas Electro Cloro, S. A., Brazilian subsidiary of Solvay & Cie., has been licensed to use Phillips Petroleum Co.'s newly developed catalytic process to make rigid polyethylene in Brazil. IQEC has exclusive use in Brazil of Phillips patents and technical knowledge to produce this new family of plastics. Parent company, Solvay & Cie., headquartered in Brussels, Belgium, previously had been granted exclusive rights to use this process in Italy.

Rheinische Olefinwerke, at Wesseling near Cologne, West Germany, will step up polyethylene production from 10,000 tons/yr. to between 30,000 and 35,000 tons/yr. Expanded facilities are expected to be operating by the end of 1958 and will cost about 140 million Deutsche Marks ($33.4 million).

Neoprene, Vinyl Acetate Get Boost in Britain

Within a few fortnights, Du Pont Co., Ltd., will begin construction of a neoprene plant near Londonderry in Northern Ireland. Approval for the plant came earlier this year from Bank of England and Capital Issues Committee.

British Oxygen has announced that its subsidiary, Carbide Industries, Ltd., will build an acetylene plant on a 50-acre site near Du Pont's neoprene plant. Acetylene will be produced primarily for the Du Pont operation.

National Adhesives, Ltd., affiliate of National Starch Products, Inc., put on stream in March a vinyl acetate polymerization plant in Slough, England. Polymer will be used in packaging, paper, textiles, coatings and pigments.

Convention Calendar

American Society of Mechanical Engineers, Instruments & Regulators Div., 3rd annual conference, Northwestern University, Evanston, Ill., Apr. 7-10.

American Chemical Society, 131st national meeting, Municipal Auditorium, di Lido Hotel, McAllister Hotel, Miami, Fla., Apr. 7-12.

American Society of Mechanical Engineers, spring meeting, Hotel Dinkler-Tutwiler, Birmingham, Ala., Apr. 8-10.

United States World Trade Fair, International Exposition, New York Coliseum, New York, Apr. 14-27.

American Society for Testing Materials, in conjunction with American Institute of Chemical Engineers, American Nuclear Society and Society for Nondestructive Testing, symposium on testing applications in the nuclear field, Morrison Hotel, Chicago, Apr. 16-18.

Bituminous Coal Research, annual meeting and Techno-Sales Conference, Greenbrier Hotel, White Sulphur Springs, W. Va., Apr. 18-19.

Association of Consulting Chemists & Chemical Engineers, Hotel Belmont Plaza, New York, Apr. 24.

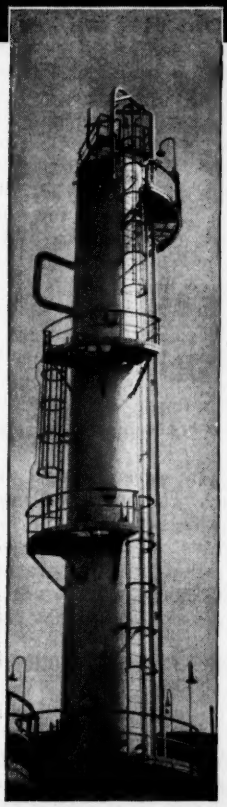
National Industrial Research Conference, Conrad Hilton, Hotel, Chicago, Apr. 24-25.

American Pharmaceutical Assn., Hotel Statler, New York, Apr. 28-May 3.

American Oil Chemists' Society, Roosevelt Hotel, New Orleans, Apr. 29-May 1.

American Ceramic Society, 59th annual meeting, Statler Hilton Hotel, Dallas, Tex., May 5-9.

160-ft. diam. HORTON TANK



8 ft. diam. by 80 ft. high CO_2 absorber tower at Grace Chemical Company, Memphis, Tenn. It was X-rayed and stress relieved before shipment. This tower and the aqua ammonia tank were furnished through Foster Wheeler Corporation.

. . . efficient storage container for "agricultural vitamins"

(aqua ammonia)

Aqua ammonia, containing the highest percentage nitrogen content of all fertilizer compounds, is stored in the 160-ft. diam. by 30-ft. high Horton® tank shown above. This tank, together with a CO_2 absorber tower, a 15,000-bbl. Hortonsphere® and a fuel oil storage tank were all built by CB&I for the Grace Chemical Company nitrogen plant at Memphis, Tenn.

Chicago Bridge & Iron Company has complete facilities to design, fabricate and erect steel plate structures. Each of the four plants is equipped for X-raying, stress-relieving and pickling and painting by the Horton Process. Please write our nearest office for further information.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

Double Shell Hoards Btu.'s

Spray dryer handling sodium phosphate puts to work waste heat from polyphosphate calciner, reducing radiation losses and smoothing temperature changes.

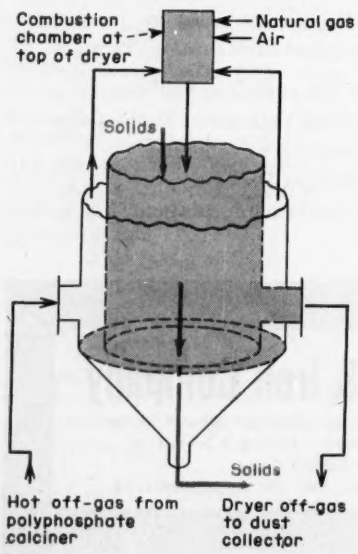
Standout engineering—as well as physical—feature of Shea Chemical Corp.'s new polyphosphate plant at Dallas, Tex., is the 100-ft.-tall spray dryer for drying sodium phosphate slurry pictured at the left.

Its double-shell design, according to Shea engineers, simplifies construction, slices radiation heat losses, facilitates operational control and turns out top-quality product. Hot offgas from the plant's polyphosphate calciner passes up through the annular space, providing an insulating envelope and taking the brunt of external temperature changes.

▶**Improved Copy**—Shea's Dallas plant, rated at 75,000 tons/yr. of phosphoric acid and 60,000 tons/yr. of sodium polyphosphate, swung into operation in January. Along with a similar facility due on stream at Adams, Mass., this month, the new plant is helping Shea upgrade its more-than-doubled phosphorus production spewing from a new, giant electric furnace at Columbia, Tenn. (*Chem. Eng.*, Dec. 1956, pp. 120-122).

While following stage for stage Shea's three-year-old acid-polyphosphate operations at Jeffersonville, Ind. (*Chem. Eng.*, Dec. 1954, pp. 132-134), the Dallas installation shows what an alert outfit can learn from a few years' operating experience. For Shea engineered a packet of neat equipment innovations into the Dallas plant that garner handsome investment and operating savings not available at Jeffersonville.

The spray dryer is the outstanding example. But Dallas proved an equally adept student of Jeffersonville experience right down the flowsheet line. The phosphoric acid plant came in for a number of effective revisions, and polyphosphate storage space was halved.



▶**Two Shells vs. Insulation**—In the new spray dryer, as well as in Jeffersonville's unit, sodium phosphate slurry is atomized at the top, sprays into a cocurrent hot gas stream from a natural-gas-fired combustion chamber. Drying into beady granules, the phosphate falls into the cone bottom.

But setting the Dallas dryer apart is its double-shell chamber design. Actually two concentric 100-ft.-high cylinders, the inner one measures 24 ft. dia. and the outer one 29 ft. dia.

The Dallas unit doesn't require a costly insulation, as does its Jeffersonville cousin. For this job, it uses free calciner offgas, once destined for waste.

▶**Recovers Heat**—Further, the calciner effluent joins the combustion gases at the top of the dryer to provide additional, and free, drying heat.

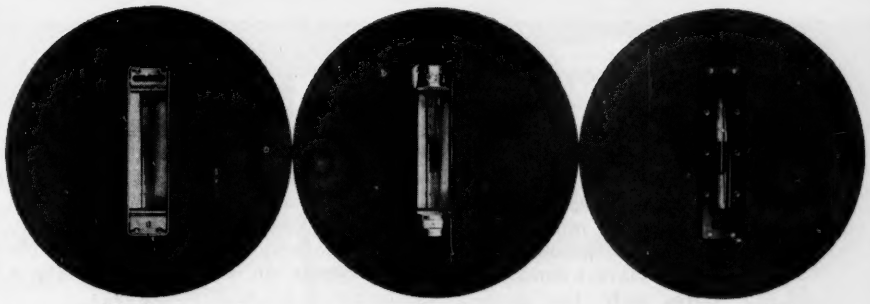
While Jeffersonville also harnesses its waste calciner gas in this manner, it needs expensive, heat-resistant ductwork to carry it into the dryer. At Dallas the annular space replaces the ductwork.

Six 12-in. pipe columns support each chamber wall separately. This allows for different rates of shell expansions due to jacket gas temperatures of about 250-300 C. and inside gas temperatures of some 500-700 C.

▶**Topside Burner**—Following Jeffersonville's lead, Dallas placed its combustion chamber on top of the spray dryer, instead of at its base, the conventional position. This cut out some 100-odd ft. of costly ductwork, with its attendant heat losses.

But going Jeffersonville one step better, Dallas mounted the combustion chamber vertically, to fire directly into the dryer. This beat the need for even that much ductwork that Jefferson-

the design you want...



sideplate
Rugged general-purpose basic design. For non-hazardous uses.

enclosed
Attractive design with stainless bezel; gasketed safety glass cover.

pressure sealed
Strongest of all. Resists breakage. Contains liquid if glass ruptures.

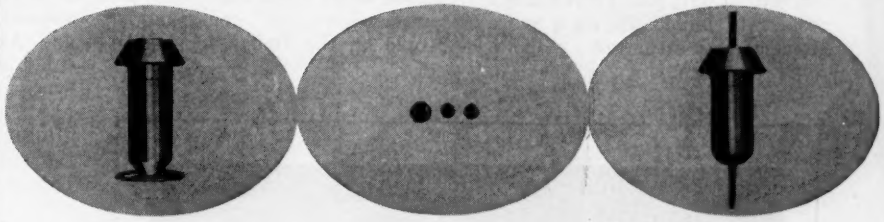
with the right glass tube...

bead guide
For general use giving high accuracy over wide range.

tri-flat
For use with ball floats to meter low flow rates.

plain tapered
For special fluids and those containing solid particles.

and float...



nail head
2 types, 7 sizes for use with bead guide tubes.

ball
4 materials in 3 sizes for tri-flat tubes.

special
For highly corrosive fluids or specialty applications.

make these stainless steel enclosed flowmeters the right choice for corrosive conditions

These engineering alternatives just begin to describe the reasons why the 1700 Series variable area Flowrator meters offer the right solution to corrosion problems. Further, you can select from more than twenty different proven materials for corrosion-proof end fittings and floats. Add to this the stainless steel enclosure for all models, plus the neoprene backed Teflon packing liners, and the applications of the 1700 Flowrator are limited only by those that would affect glass.

All 1700 Series Flowrators embody proven engineering principles for measuring any flow accurately up to 200 gpm of water, 400 scfm of air. Pipe connections—horizontal or vertical, screwed or flanged—can be made from any direction through a provision for 360° rotation of connection. Full data on the 1700 Series is given in Catalog 10-A-25. For your copy, write Fischer & Porter Company, 147 County Line Road, Hatboro, Pennsylvania.

FP

FISCHER & PORTER CO.

Complete Process Instrumentation

ville uses to carry the gases from its horizontally mounted combustor.

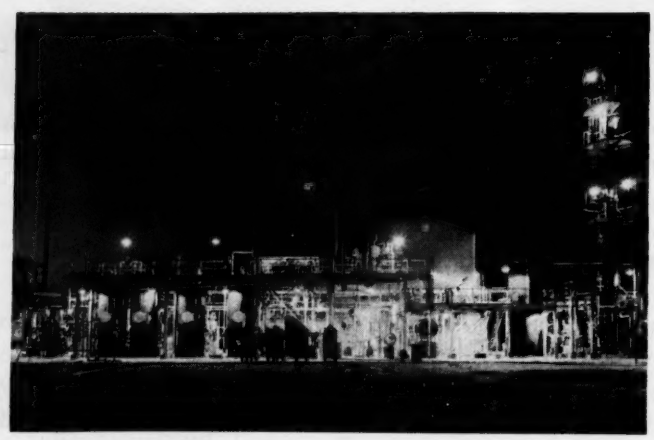
▶ **Storage-Space Slice** — While Jeffersonville stores milled and screened phosphate products in anticipation of market demands, Dallas stores only the semi-finished product from the rotary calciner.

Ten 30-ft.-high by 12-ft.-dia. silos provide adequate storage facilities for the phosphates. And Dallas counts on its big Raymond mill, with a 72-in.-dia. housing and 55-in.-dia. rotor—the largest size made—to keep up with specific orders as they come in. This arrangement, Shea estimates, halved storage space needs by cutting down product inventory requirements.

▶ **Other Touches**—In the acid plant the quonset-hut-shaped oxidation-hydration chamber design used at Jeffersonville yielded to a box-shaped graphite unit at Dallas. Thus Shea came up with a unit that proved much easier to build, offered a more impervious structure with a much larger cooling surface for maximum heat dissipation.

Dust and mist separators at stages in the acid and polyphosphate plants secure 99.9% materials recovery, Shea reports, and eliminate all air pollution headaches. A multiple-throat venturi-type wet scrubber, adapted from Shea's elemental phosphorus plant, is used on the gases from the sodium phosphate reactor. And Shea now plans to try it out in the acid plant to recover acid mist. Shea expects this unit to handle some 40% of all acid produced.

▶ **Home-Grown Talent** — Shea credits these cost-cutting innovations to its philosophy of teaming operation, engineering and construction people in a single outfit. The Dallas plant, from its earliest designs right down to and including equipment fabrication, was the work of Shea's own staff. Says Shea, "Our operating people at Jeffersonville passed along their experience to our design and construction people on the Dallas job. This made for a streamlined process that was built faster and more economically."



Southwest Plant to Make Low-Pressure Polyethylene

Just on stream is Celanese Corp.'s new 40-million-lb./yr. low-pressure polyethylene plant near the Houston Ship Channel.

Product, called Fortiflex, will be used for wire and cable insulation, bottles, packaging film, housewares, toys, industrial housings, automotive parts, pipe and fittings.

Located on a 220-acre site south of San Jacinto State Park, the plant will ship to customers by trailer truck and trans-shipment by boat. All shipments will be in pellet form.

U. K. Blames Reactor Snag On Creep From Radiation

Long-rumored troubles with fuel elements at Britain's Calder Hall atomic power station were confirmed recently by Sir Christopher Hinton of the U. K. Atomic Energy Authority.

Hinton revealed that bursting of the lower fuel elements, which resulted in a station shutdown, had been caused by strut failure of the elements. Failure, he explained, had been induced by a higher irradiation creep rate than originally predicted at the design stage.

Research work at Harwell, main AEA research center, had forewarned that the bowing rate of the lower fuel elements might be greater than allowed for. But no facilities at that time could simulate operating conditions, and AEA had to wait until it could investigate Calder Hall operations.

All AEA reactor designs, said Hinton, can incorporate a system of restraint which would bypass the Calder Hall trouble.

Du Pont Slates Expansion For Silicon, Ti Pigments

Du Pont will build the U. S.'s first full-scale plant to produce high-purity silicon at Brevard, N. C. Construction is now under way for the 70,000-lb./yr. plant, to be on stream early in 1958.

Semiconductor-grade silicon (price: $320/lb.) will be used in transistors, diodes and power rectifiers. Solar-cell-grade silicon (price: $150/lb.) will be used in solar cells to convert the suns rays into electrical energy.

Du Pont's present small-scale silicon plant at Newport, Del., will continue to be used for research and development.

A third titanium dioxide plant, near New Johnsonville, Tenn., will join Du Pont's other two TiO_2 plants early in 1959 and will produce 125 tons/day of the white pigment. The new plant will use DuPont's chloride process.

J. L.
Did these centrifuges
come up to expectations
in our plant?
W. K.

RING
UMMARY REPORT

SUBJECT: Test Program—Sharples Super-D-Hydrator for recovery of sodium chlorate crystals.

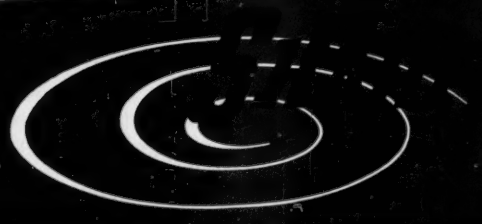
MATERIAL: Slurry from evaporative crystallizer. (25% concentration)

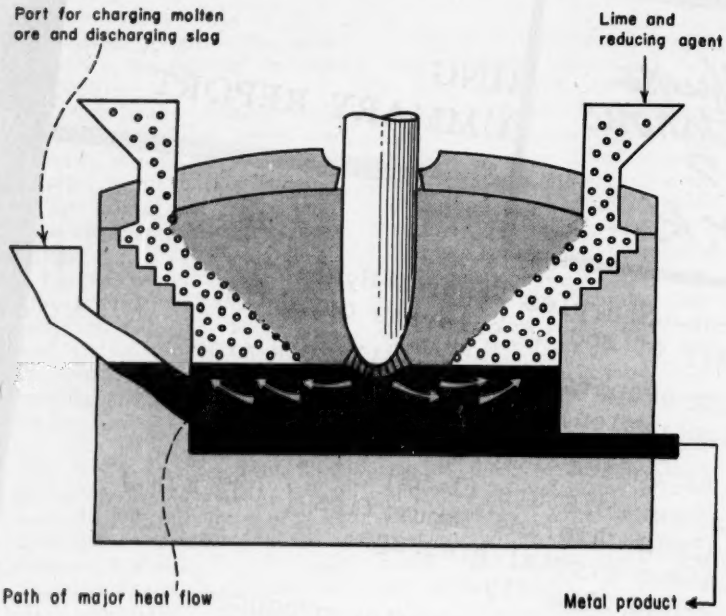
OBJECTIVES: Recovery of sodium chlorate crystals with:
(1) Minimum moisture (1.5%)
(2) Minimum chloride impurities (.03% max.)
(3) Minimum crystal breakage
(4) Maximum capacity

RESULTS: Tests on C-27 Super-D-Hydrator produced the following:
(1) Residual moisture 1.5%
(2) Chloride impurities .015%
(3) Vibrator leveler minimized breakage
(4) Capacity 5,500 lbs/hr.
(5) Rinse water only 3% of weight of crystals

ACTION: Tests highly successful. Recommend purchase of two Super-D-Hydrators for present plant. Indicated also for contemplated plants.

You bet-we're getting 7500-8000 lbs./hr. regularly instead of 5500. Suggest new Sharples model with quick-opening doors for expansion program.
J. L.





Short arc and careful feeding give close temperature control, low fume losses. Stepped sides direct feed into slag, avoid agglomeration.

Key to Low Recovery Costs

Now winning ferromanganese from low-grade ore in a prototype plant, the new Udy arc furnace could tap virtual mountains of other low-grade ores and wastes.

On the Canadian side of the Niagara River, near the famous falls, is a brand-new, $2-million prototype metallurgical plant. It mirrors the imagination of a man who throws the book out the window with a confidence belying his years.

Sixty-three-year-old Marvin Udy, much-esteemed chemical engineer and metallurgist and past president of the Electrochemical Society, is still doing things differently. This time he's developed an electric-furnace smelting technique which he and his colleagues of Strategic-Udy Metallurgical and Chemical Processes, Ltd. (Sumac), believe will win metal values from ores and wastes that have heretofore defied economical processing.

First on the list: low-grade manganese ores in this country and Canada. Udy says he can recover commercial ferromanganese from these sources at least as cheaply as other producers process high-grade ores.

There are mountains of ore waiting for the picking—from U. S. government stockpiles and from mines owned by Sumac's parent, Strategic Materials Corp., in the province of New Brunswick.

▶ **Only the Beginning**—And if Udy proves his point with manganese recovery, there's urgent work to be done by the same process on low-grade chromium deposits. Other process variations stemming from the same basic furnace techniques may prove the first practical answer to high-iron bauxites, red mud waste from Bayer alumina process, many titaniferous and nickel ores, and metal sulfate wastes.

Udy has gone against established principles before and won out. His most pressing project, ferromanganese production, has already been checked out at Canada's Bureau of Mines & Resources (Ottawa), at the Sault Ste. Marie plant of Chromium Mining & Smelting Corp. and in his own furnace (100 kw.) in Niagara Falls, N. Y.

Now in Sumac's prototype plant—equipped with three 1,000-kw. furnaces—the ferromanganese process looks even better than it did in the laboratory.

▶ **Manganese Into Slag**—Pivotal technology of Udy's ferromanganese process lies in his novel smelting techniques.

In the first of three electric furnaces, molten ore is smelted at 1,350 C. with lime and coal. A controlled amount of iron and impurities — principally phosphorus—are reduced to the metallic state and removed. Functioning as a basic flux, virtually all the original manganese—upgraded, now, to 35% and low in P—remains in the slag.

Molten, Mn-rich slag moves to a second furnace, reacts with more flux and reducing agents to produce either high-carbon ferromanganese or ferromanganese silicon.

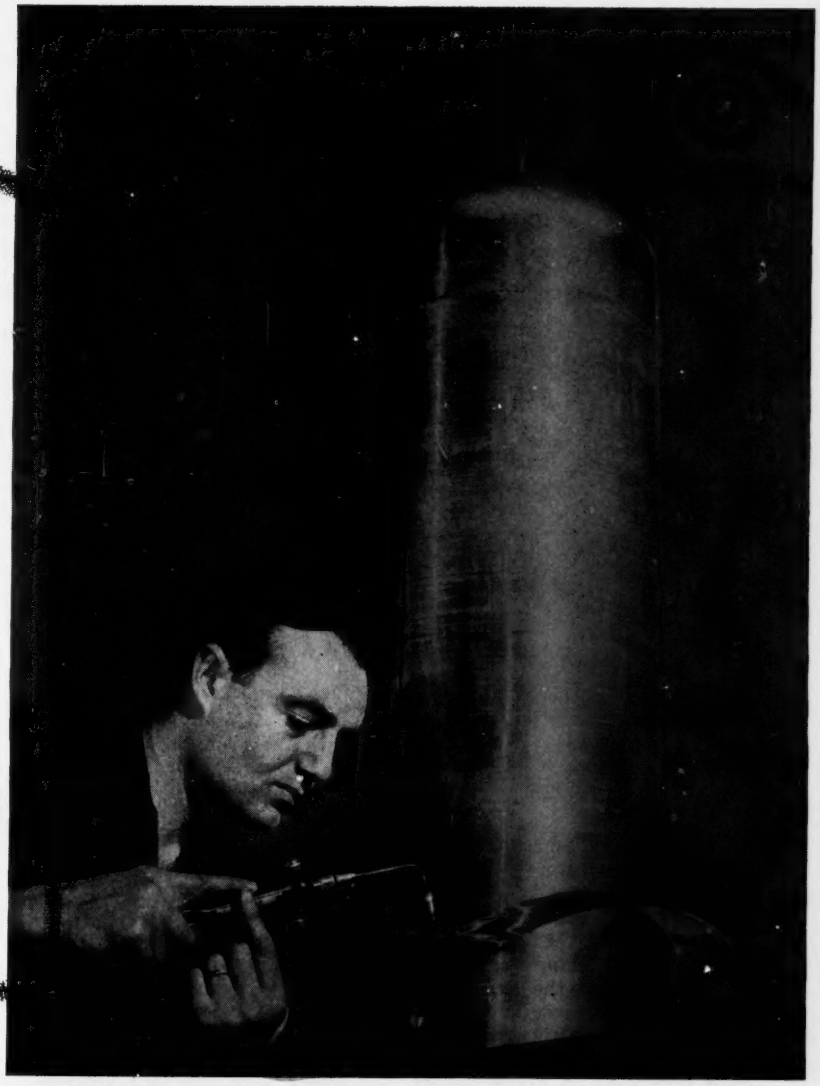
Latter product can be used as the reducing agent in a third furnace to convert Mn-rich slag from first furnace to either low-carbon or medium-carbon ferromanganese.

▶ **Liabilities Into Assets**—Sumac's process capitalizes on, and preserves, economic advantages of cheap ore in these ways:

- Close temperature control prevents volatilization of manganese. Normal furnace operation may lose 5-7% manganese as fumes out the top.
- Preliminary iron removal pulls out phosphorus, upgrades Mn in the slag—and gives ingot iron, a marketable byproduct, to boot.
- Fluxing with manganous oxide in first stage reduces lime consumption, minimizes formation of high-melting-point slags. These slags, in turn, would require high temperatures for smelting and lead to high volatilization losses of Mn.

▶ **Furnace Features**—By positioning electrodes between ½ in.

a reactor of gold for hot atoms



This Nooter expert is welding a solid gold liner for an experimental reactor to be used by the Los Alamos Scientific Laboratory.

From the resulting tests, the Atomic Energy Commission hopes to gather enough data to make possible the design of a portable power source for future military outposts.

The fabrication and weldment of pure gold on such a large scale is probably without precedent, but Nooter has been in training for difficult pure metal and alloy fabrication jobs for many years.

The Nooter Research Laboratory has pioneered and improved welding techniques on many metals. To you, this means better processing equipment, in the pure metal or alloy most suitable to your needs.

Your next tank or vessel job may not be as unusual as the reactor shown here, but you can be sure of one thing—it will receive the same care and attention to detail given to every Nooter assignment. May we serve you soon?

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Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

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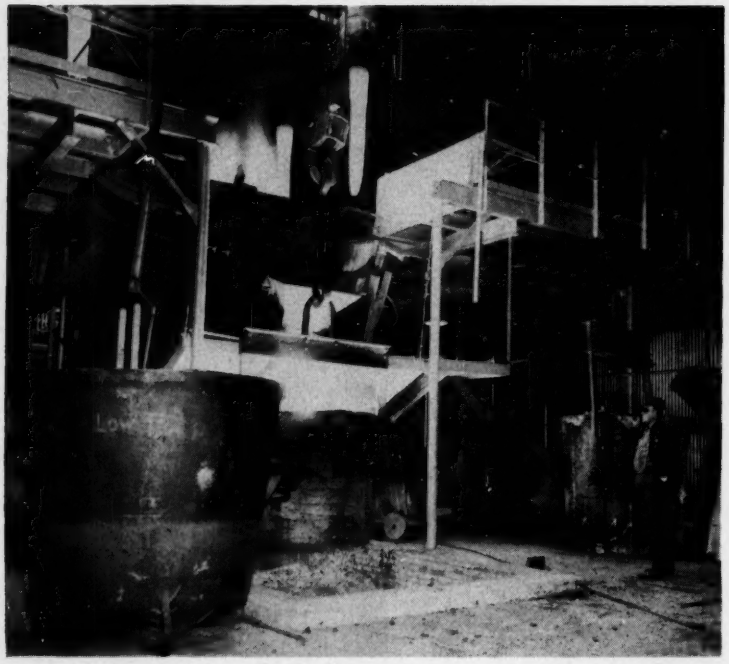


OPERATING results on low-grade manganese ores surpass estimates.

above slag level and 2 in. below (arc pressure prevents wetting), Udy gets combined arc-resistance and slag-resistance heating.

By carefully feeding his reducing and fluxing agents in solid form onto the surface of the slag bath, away from the arcing tips of the electrodes, he avoids agglomeration of solids and formation of high-pressure zones that occur when charge is packed deeply around electrodes.

Close, short arc concentrates heat application. Careful feeding precludes uneven heating, with hot spots, which may blow manganese away as dust or vapor.

Maintenance of nominal slag depth at not less than 3 in.—to keep at least 1 in. of slag between arc and metal—further assures nearly constant resistance and, with steady power input, nearly constant temperature.

▶ **Better Power Factor** — Short arcs and constant resistance combine to yield power factors of 95%, compared to the 75-85% typical of other arc-furnace practice.

Joining other tight checks on manganese losses is the use of calcium carbide in the ferromanganese reduction stage (second furnace). For trace amounts of CaC_2 dramatically favor an equilibrium shift for Mn away from the slag and into the ferroalloy. Manganese retained in waste slag is less than 1% of that in ore; standard practice loses 5-7% this way.

Other Udy furnace innovations: Side walls sloped like angle of repose of charge and stepped to retain protective coating of charge material. Udy uses magnesite, rather than carbon, for his inner lining—to keep carbon low in his product. Carbon, in turn, backs up the magnesite, serves to carry heat away and reduce corrosion and erosion of inner lining.

▶ **Have Process, Will Travel**—A young, aggressive company looking for its first breakthrough, Strategic Materials is banking heavily on the prototype operation to prove out the ferromanganese process, as well as others. A breakthrough could come at the Woodstock, N. B., mines if the technique meets the test and Strategic gets the money to build a $15-million, 75,000-ton/yr. FeMn plant.

Inasmuch as Strategic's management has, for the present, apparently rejected financing via stock dilution and frowns on licensing until it has a marketable product, money for the New Brunswick project will have to come from a loan or—and this looks pretty reasonable—from a joint partnership with, say, a steel producer.

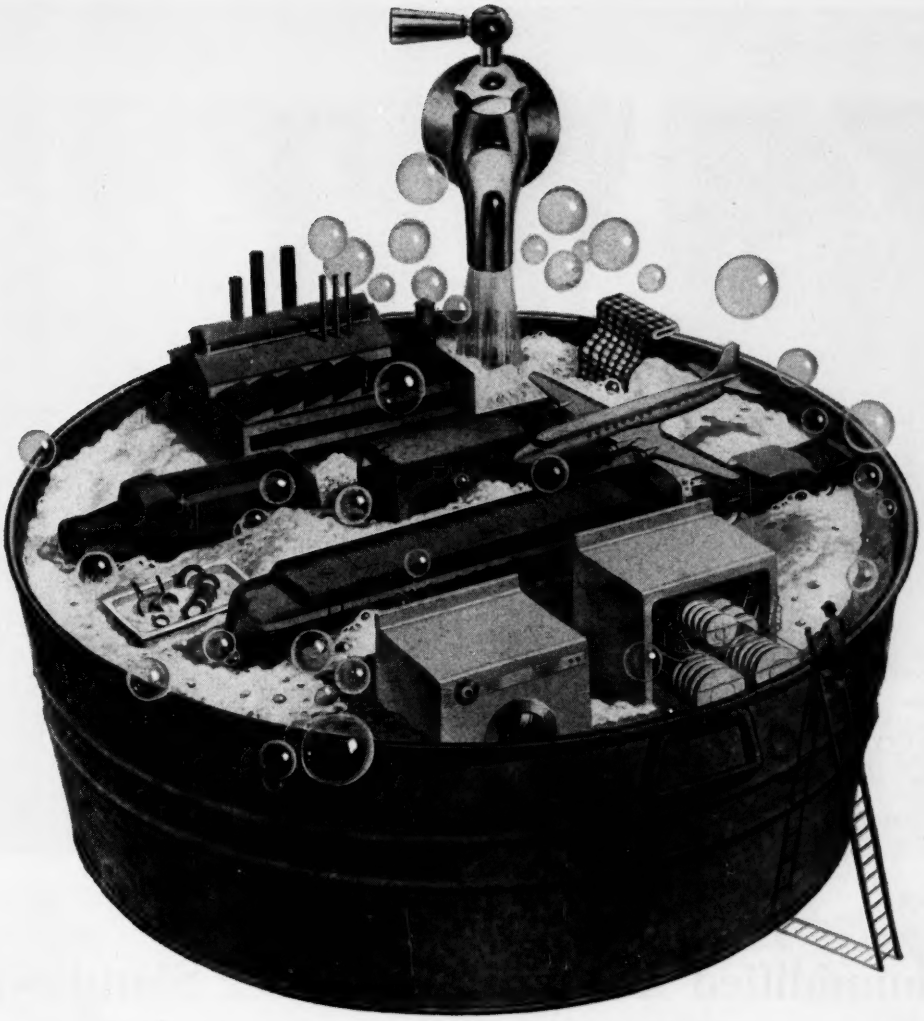
▶ **Basic Economics**—Three economic lures dominate the Strategic ferromanganese picture:

- Cheap raw materials—It takes 2 tons of high-grade (48%) manganese ore to get 1 ton of high-carbon ferromanganese; it takes 6 tons of New Brunswick ore. But the low-grade stuff can be delivered to the smelting plant for $1.50-4.00/ton, whereas high-grade ore costs $60/ton. Thus Udy has savings of close to $100/ton of FeMn from the start.
- Premium byproduct—One ton of iron is available for every ton of ferromanganese. Easily refined to ingot-grade, it should yield a credit of $50/ton.
- Corporate income tax exemption—Three-year period of grace extended by Canadian government helps investors recoup venture capital.

▶ **Control Power Costs**—Others have started with low-cost manganese ores and flopped. Problem has always been to handle vast bulks of raw materials without letting added costs (especially for power) and mechanical losses dissipate initial savings on ore.

Udy's latest estimates make it appear as if he has, indeed, preserved much of his raw-material advantages. Power consumption is around 3,500 kwh./ton FeMn (comparable to standard electric furnace work with high-grade ores). Mn recovery reaches 95%. Operating cost per ton FeMn (not including general overhead, selling and administration expenses, depreciation allowances and local taxes) runs no more than $150. If Strategic can realize $50/ton ingot iron and $245/ton FeMn, then its net before taxes could be as high as $100/ton of FeMn.

At this rate a 75,000-ton/yr. Canadian plant will pay for itself within three years, before corporate income taxes start.



In just 10 years—with Oronite ALKANE* a 2,000 year custom has been washed away

For some 2,000 years "washing" meant only "soap." But in the short span of ten years the acceptance of synthetic detergents by the soap industry and consumers has seen detergents almost completely replace soap in the washing machine and dishpan. Oronite is proud to have played a major role in changing an established world-wide custom so quickly and completely.

The spectacular success of Oronite ALKANE, as the world's leading detergent raw material, has been due to Oronite's continuous multi-million dollar research, product development and manufacturing program coupled with application of large-scale continuous processing methods. This program has led to an imposing list of patents and has established Oronite ALKANE as the one standard of quality, the unduplicated raw material of the detergent industry.

Marketing the leading detergent raw material also brings a responsibility to the future. As in the past, millions of dollars are being invested in research and manufacturing facilities to assure that "you can expect from Oronite, whatever is new or better in detergent raw materials."

For the highest quality detergent raw material, or help on sulfonation processes, contact your nearest Oronite office.

*Trademark for detergent intermediate

ORONITE CHEMICAL COMPANY

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20 North Wacker Drive, Chicago 6, Illinois
Mercantile Securities Building, Dallas 1, Texas
Carew Tower, Cincinnati 2, Ohio
714 W. Olympic Blvd., Los Angeles 15, Calif.

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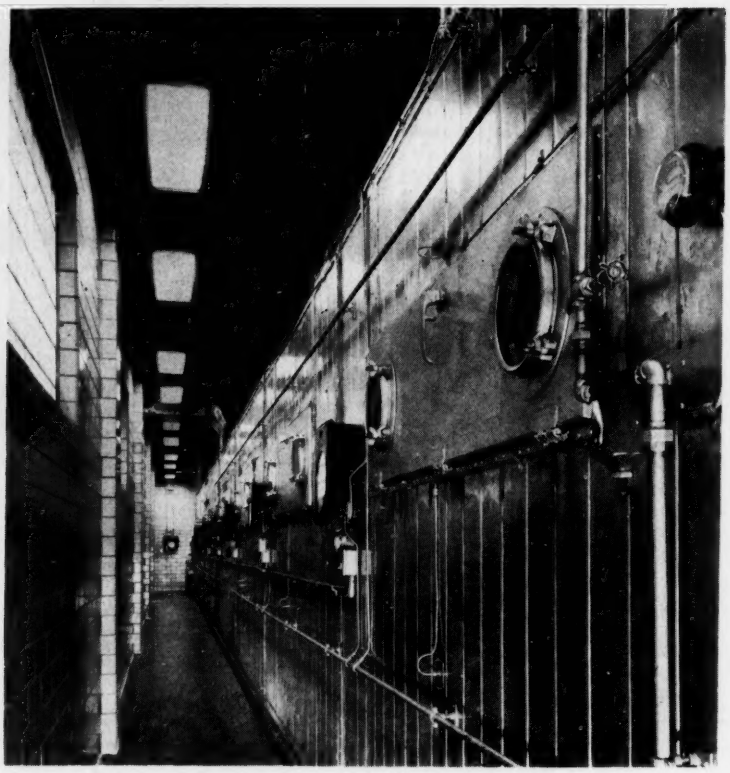


When drying materials like gelatin that can't stand heat . . .

Dehumidified Air Avoids Summer Shutdown

Over-all modernization program at AAC's gelatin plant includes new continuous dryer which alone saves up to 5¢/lb. of product.

This new high-speed, low-temperature dryer is already racking up daily savings at American Agricultural Chemical's gelatin plant in Detroit. It's a key unit in AAC's wholly new processing plant set up to turn out 8,000 lb./day of pig gelatin.

AAC figures the new facilities save a tidy bit over older methods. Credit for 5¢ of these savings (per lb. of product) goes to this dryer, which handles the entire gelatin output.

First venture in drying equipment for Surface Combustion Corp., Toledo,* the dryer is sold as part of a processing package which includes a chilling and mixing unit (a Girdler Votator) and extrusion equipment. The extruder forms chilled gelatin into small noodles for rapid drying.

Complementing the dryer from time to time is a Kathabar (lithium chloride absorption) dehumidification unit—also supplied by Surface Combustion—which assures smooth, efficient year-round drying independent of weather conditions.

▶**Dryer Operation** — AAC's dryer, 80 ft. long and 12 ft. wide, removes 1,400 lb. water/hr. from noodle gelatin to produce about 400 lb./hr. of 90% gelatin (from 25%-dry feed). It pulls in 25,000 cfm. of air at 40 grains and 85 F. (supplied in humid weather via the Kathabar unit) and exhausts about half of this at 130 grains and 140 F. (Old and rambling forced-air tunnel dryers needed 300,000 cfm. of similar air to handle same production volume.)

Heat requirements: 2.5 lb. steam/lb. water removed. Power requirements: 300 hp., sufficient for Votator, extruder, gel pumps, dryer belt, grinding equipment and fans.

Retention time: 2 hr., vs. 24-36 hr. in old dryers. Labor: 3 men per shift vs. 17.

At 8,000 lb. throughput per day, the 5¢/lb. drying savings

* Surface Combustion's earliest gelatin effort was a revamping of another manufacturer's continuous-conveyor dryer at an Atlantic Gelatin plant. Second SC-built dryer went into a Hormel gelatin plant this spring. Peter Cooper Co. will get another (for glue drying) this summer and Wilson's Organic Products Div. will put one into service fairly soon.

...more quality proved POWELL VALVES

FIG. 2309—Flush Bottom Tank Valve for 150 Pounds W.P.

FIG. 2491—Stainless Steel O.S.& Y. Gate Valve for 150 Pounds W.P.

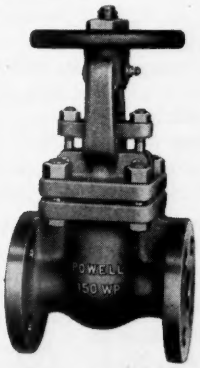
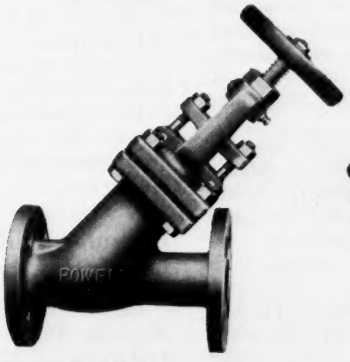
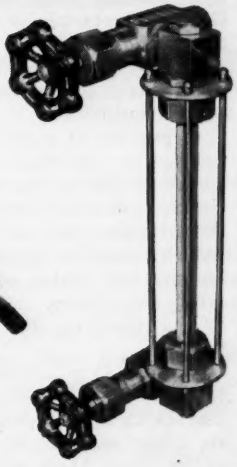


FIG. 1886—Stainless Steel Liquid Level Gauge for 350 Pounds W.W.P. Offset pattern.

FIG. 2107—Stainless Steel "Y" Valve for 150 Pounds W.P.





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THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

should pay for the $250,000 dryer within three years.

▶**Gelatin Processing** — New dryer fits into process scheme like this:

Concentrated pig gelatin extract is chilled in the Votator, extruded into ⅛-in.-dia. noodles. Gelatin noodles fall onto a rubber conveyor belt, move to another conveyor which, as it oscillates back and forth, piles them 5 in. deep on perforated dryer conveyor belt. Porous noodles present good drying surface, permit free air passage through the bed.

Air is passed at about 1,000 ft./min. from the charge end to the discharge end, alternately passing up and down through the gelatin bed between seven internal partitions. Dryer provides for reheating and partial exhaustion of air at several points along the line, as well as for cooling dried product prior to size reduction.

▶**It's the Humidity**—Dehumidification of air for drying pays real dividends in gelatin industry, what with the problem of adequately drying a heat-sensitive product with humid air. Gelatin plants wholly dependent on unconditioned air must shut down for the summer months, often accept lower efficiencies in other months.

A portion of current gelatin production—in flake and sheet form—is still unadapted to continuous conveyor drying. Since these forms can be produced only by carefully drying chilled rectangular slabs of gelatin, AAC and others retain tunnel drying facilities for this purpose.

Surface Combustion, anxious to throw open the entire gelatin market to its equipment, claims its dryer can handle this kind of product economically, although it will, of course, take longer to dry it.

▶**Shifting Patterns** — There's more to the story of this modern high-speed dryer than straight operating details. For the unit typifies an "agonizing reappraisal" thrust upon the gelatin industry in recent years.

Gelatin processing is among our country's oldest industries, an industry whose customers had long demanded, gotten—and paid for—many special grades, shapes and forms of gelatin product for photographic, food and pharmaceutical usage.

AAC had built a rather tidy specialty business by supplying its customers precisely the kind of gelatin each wanted.

Then, as gelatin outlets expanded rapidly, product standardization won increasing favor. Low-priced imported gelatin appeared. Batch processing, variable operations, excessive manual materials handling—in short, the demands of specialty processing—could no longer be wholly justified.

AAC, like many others, had to streamline or get out of the gelatin business. The new plant keeps them very much in business.

Air-Oxidation Process Now Making Niacin

Niacin, via a new air-oxidation process, is now in large-scale production at Cowles Chemical Co.'s Skaneateles Falls, N. Y., organic synthesis plant.

Process details are still under wraps, but Cowles says the process operates with or without catalysts. Reactor and equipment—using stainless steel, glass linings and other nonreactive materials—are designed to withstand highly corrosive materials and extreme temperatures and pressures.

Niacin U.S.P., Cowles says, will be aimed at chemical, pharmaceutical, glass fiber, resin and plastic markets.

Feed-grade niacin will be sold for use in compounding animal feed supplements.

Hercules Will Boost Oxychemicals Output

On stream early this year, Hercules Powder Co.'s new 3-million-lb./yr. Gibbstown, N. J., para-cresol unit will soon be joined by another one of about the same capacity.

Also in operation now are facilities for converting para-cresol to di-tert-butyl para-cresol, used in antioxidants, fatty oils and synthetic hormones.

Both units use a process developed by Hercules, similar to its phenol-from-cumene oxidation process. Raw material for para-cresol is para-cymene made from monocyclic terpenes.

Di-tert-butyl para-cresol products will be known as Dalpac. Dalpac 4 is antioxidant, Dalpac FG (food grade) is used in edible and inedible fats and oils and in animal and poultry feed.

News Briefs

Insecticide: Chas. Pfizer & Co. has acquired a process patent (U.S. 2,768,967) for a new method of making allethrin, a compound for spray and aerosol insecticides. Pfizer will license the process, but will not make allethrin.

Research center: Atlas Powder Co. will build a $3-million Technical Center near Wilmington, Del., to intensify long- range basic research and expand technical service. The center, scheduled for completion by year's end, will house the firm's chemical research and product development departments.

Formaldehyde: Borden Co.'s Chemical Div. has on stream a new 36-million-lb./yr. formaldehyde plant at Kent, Wash. The new plant, first to use the Karl Fischer process, makes Borden the largest formaldehyde producer on the West Coast.

Chemical Progress Week: Manufacturing Chemists' Assn. will sponsor the fourth annual Chemical Progress Week during Apr. 8-12.

Benzene hexachloride: Frontier Chemical Co., Wichita, Kan., now has available for delivery both 36-gamma technical and 13- to 15-gamma benzene hexachloride.

Polyethylene: Texas Eastman Co. has boosted capacity of its Longview, Tex., polyethylene plant to 55 million lb./yr. and has completed installations at Kingsport, Tenn., for compounding special formulations of the resin.

DISPERSE - EMULSIFY - BLEND - PUMP - CONTROL

Liquids - Slurries - Viscous and Abrasive Fluids

Here are dramatically different ways for you to handle the mixing and movement of product! This Gaulin equipment is specially designed to give a new dimension to industrial processing — *particle control.*

Particle control has a vital bearing on product quality and costs. It is put to work for you by *Gaulin Technical Assistance.* Fifty years' experience in analyzing fluids, plus complete laboratory sampling and test facilities make *GTA* the "extra" man in your product development program.

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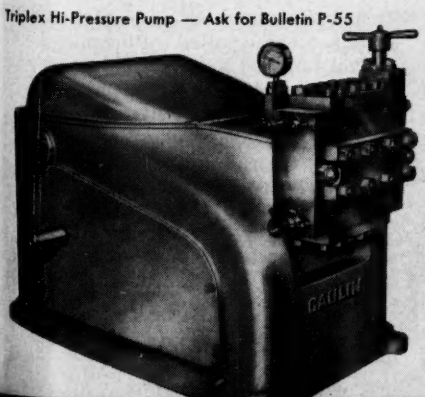
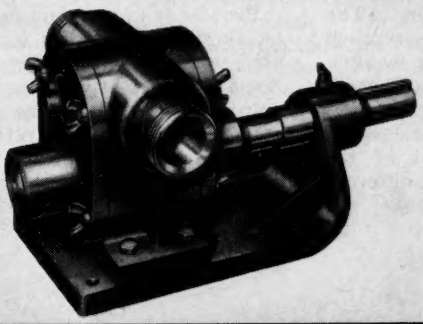
GAULIN HIGH PRESSURE PUMPS offer a versatile line for the control and movement of a wide variety of materials. **Triplex Hi-Pressure Pumps** handle large volume of all types and densities of fluids. Capacities to 6000 gph, pressures to 8000 psi, temperatures from −90°F. to +550° F. Used for all types of product — sanitary, corrosive, abrasive, viscous and volatile — for transfer, metering, injection, testing and spray drying. **New Hinckley Rotary Positive Displacement Pump** for liquids, heavy slurries and pastes, soft food solids, emulsions and gases. Also corrosive fluids. Features extreme simplicity, high mechanical efficiency and high volume at low speed. Pressures to 200 psi, capacities to 1500 gph. Pulls a full vacuum. **Gaulin HX** — hydraulic pressure exchange pump — specially designed for extremely abrasive and corrosive muds, slurries and solutions. Slow cycle operation — no plungers, no packing, pressures to 2000 psi, capacities to 120 gpm.

Ask for GTA to help you select the right pump for your requirement . . . and use *Gaulin Particle Control* to bring new cost-saving solutions to processing operations.

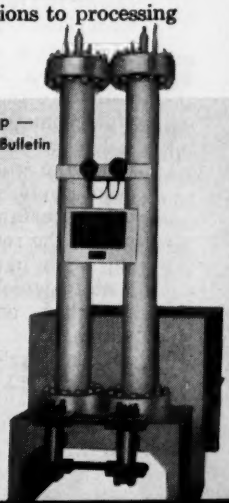
Triplex Hi-Pressure Pump — Ask for Bulletin P-55

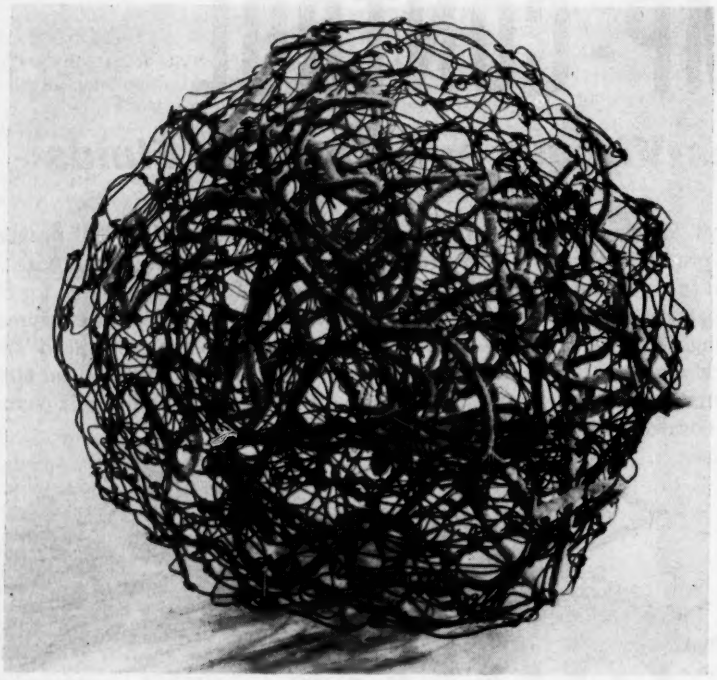


Hinckley Pump — Ask for Bulletin HR-57



HX Pump — Ask for Bulletin HPX-55





MODEL of snake-cage polymer, is built to separate water soluble materials.

Resin Separates Electrolytes

Made by polymerizing an anionic monomer inside of an anion exchange resin, it simplifies separations via "ion retardation."

Ion retardation constitutes a new, simple method for separating various water soluble materials. The technique is based on a new type of resin containing both anionic and cationic sites, located in a special geometric arrangement.

The resin absorbs both cations and anions simultaneously from aqueous solutions. The ionic substances can be washed out of the resin merely by rinsing with pure water. The extent to which various ions are absorbed, and the ease with which they rinse out of the resins, varies with different ions.

Both resin and process were developed by Dow. The resin is new; not a standard Dowex product. A typical example might be made by polymerizing acrylic acid inside of the cross-linked matrix of pre-formed Dowex 1 anion exchange resin beads (like a "snake in a cage").

Process is unique and cannot be classified as either ion exchange or chromatography. Some mixtures of water soluble substances which can be separated effectively by ion retardation are: ferrous sulfate from zinc sulfate, ethylene glycol from sodium chloride, sodium hydroxide from sodium chloride; ammonium chloride from zinc chloride; sodium chloride from sodium bromide and iodide.

Fuller details on theory and operation of ion retardation will be made available soon as will material for sampling. Typical laboratory set-up includes:

Feed—one-half resin-bed volume of solution, 0.5 normal concentration in ammonium chloride, and 0.08 normal concentration in zinc chloride

Rinse—three bed volumes of pure water

Column depth—34 in.

Total cycle time—2 hr.

Dow Chemical Co., Midland, Mich. 176A

Urethane Ingredients

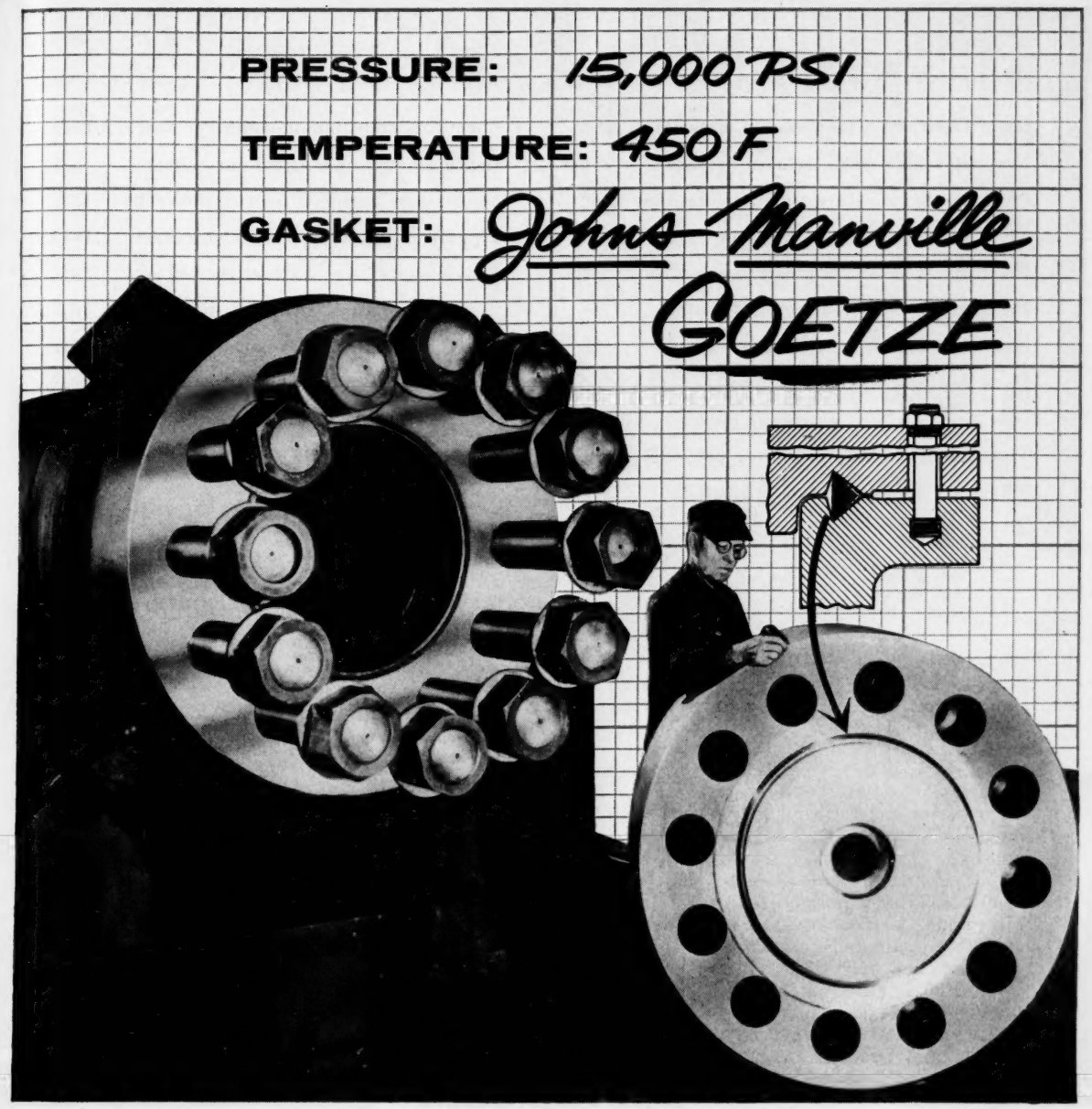
New polyester vs. three new polyethers.

Two rival types of starting materials for polyurethane foams—polyesters and polyethers—have recently added new and better members to their ranks.

Wyandotte Chemicals Corp., Wyandotte, Mich., has announced commercial availability of three polyethers distinguished by low cost and the resistance to humidity aging of foams they produce....176B

Witco Chemical Co., New York, N. Y., has announced a new polyester said to produce foams which show a minimum of deterioration and a low compression set when exposed humid aging. 176C

The Wyandotte trio, usable for both flexible and rigid foams, are called Pluronic polyol L61 and Tetronic polyols 701 and 904. They are high molecular weight polyoxypropylene-polyoxyethylene block polymers terminating in primary hydroxyl groups. The company states that, in addition to these three, others are in the process of development and will be announced within



How A. O. Smith maintains tight seals in giant "Multi-Layer" vessels

Today's tremendous pressures and temperatures have placed special demands on manufacturers of processing equipment. A. O. Smith has answered this need with a special type of "Multi-Layer" vessel construction. And Johns-Manville in turn has provided gaskets that assure tight seals under these exacting conditions. Typical of these is the delta type gasket, illustrated above, which was designed, for this application, to withstand pressures up to 15,000 psi. and temperatures to 500 F.

The development of special gaskets to meet special purposes has been the stock in trade of Johns-Manville's Goetze division for more than sixty-five years. Expert technicians possess a knowledge of metals and other factors related to gasket design and performance that is unmatched in the field. What's more, intensive specialization and modern production tooling provide substantial cost savings on J-M gaskets.

If you need gaskets for high pressure vessels for similar applications, send us a drawing or template for quotation. If you have a sealing problem of any kind, J-M technicians will work directly with your own engineers to develop new gaskets —or adapt existing styles—to meet your specific requirements. Write for further information to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit (Toronto), Ontario.

Johns-Manville PACKINGS & GASKETS

Newsworthy chemicals this month

Resin separates water-soluble materials..176A
New polyethers make low-cost urethanes..176B
Polyester for moisture-resistant urethane.176C
Vinyl plasticizer eases processing.....178A
Urethane formulation aids foam control..178B
Urethane formulation speeds foaming....178C
Cement additive strengthens ready-mix...178D
Hard, low-cost waxes from coal.....180A
New alpha olefin is unusually reactive....180B
Titanium trichloride's catalyst potential..180C
Trimethyl aluminum in pilot plant lots...180D
Chemicals set shipping-container heat....182A
Improved insoluble sulfur for rubber.....182B
Vulcanizing agent for fluorocarbon rubber.182C
Thermoplastic lining resists corrosion....184A
Molybdenum lubes work at 100,000 psi....184B
Terpene peroxides covered by new patents.184C
Bactericidal paints developed in Britain..184D
Three new nonflammable solvents.....184E
Two new grades of potassium silicate....184F
Vitamin E in new dry form.....184G
Beta sitosterol now commercial.....184H

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the next few months. All of the new products are members of the company's line of non-ionic surface active agents covered by U.S. Patent 2,674,619 and patent applications.

Wyandotte has also developed an odorless catalyst for polyurethane preparations. It enables the production of foams which are odor free even immediately after manufacture. A piperazine derivative, it is available in limited quantities.

Witco's new polyester, Called Fomrez 50, is aimed at the production of flexible foams. It features a narrow hydroxyl number and viscosity range as well as a uniformly low moisture content.

Plasticizer

High molecular weight polyester is easy to process.

Although high molecular weight polyester plasticizers have been commercial products for 10 to 12 years, their widespread usage has been restricted because of high cost and inability to be processed easily on conventional equipment. Now one has been developed, said to overcome these shortcomings while retaining the benefits of the permanence characteristics of its class.

Called Emery 3049-S, the new plasticizer provides the vinyl compounder with: optimum migration properties, outstanding extraction properties, complete compatibility, excellent electrical properties, low volatility, resistance to marring by lacquers, enamels and plastic surfaces, light color.

Suggested uses for 3049-S are in making infant accessories, upholstery material, industrial tapes and gaskets, and in 105 C. and other heavy duty electrical insulation. — **Emery Industries, Inc., Cincinnati, Ohio.** 178A

Rigid Polyurethanes

Two two-component foam-making formulations, for control, for speed.

Dayton Rubber Co., Dayton, Ohio, has developed a new two-component liquid system of polyesters and isocyanates that slows down normal urethane-foaming reactions of 30 to 60 sec. to 100 to 180 sec. This affords a safer handling margin and enables pouring into molds before the urethanes harden in the mixing vessels. In addition, new formulation gives more uniform and finer pore structure. 178B

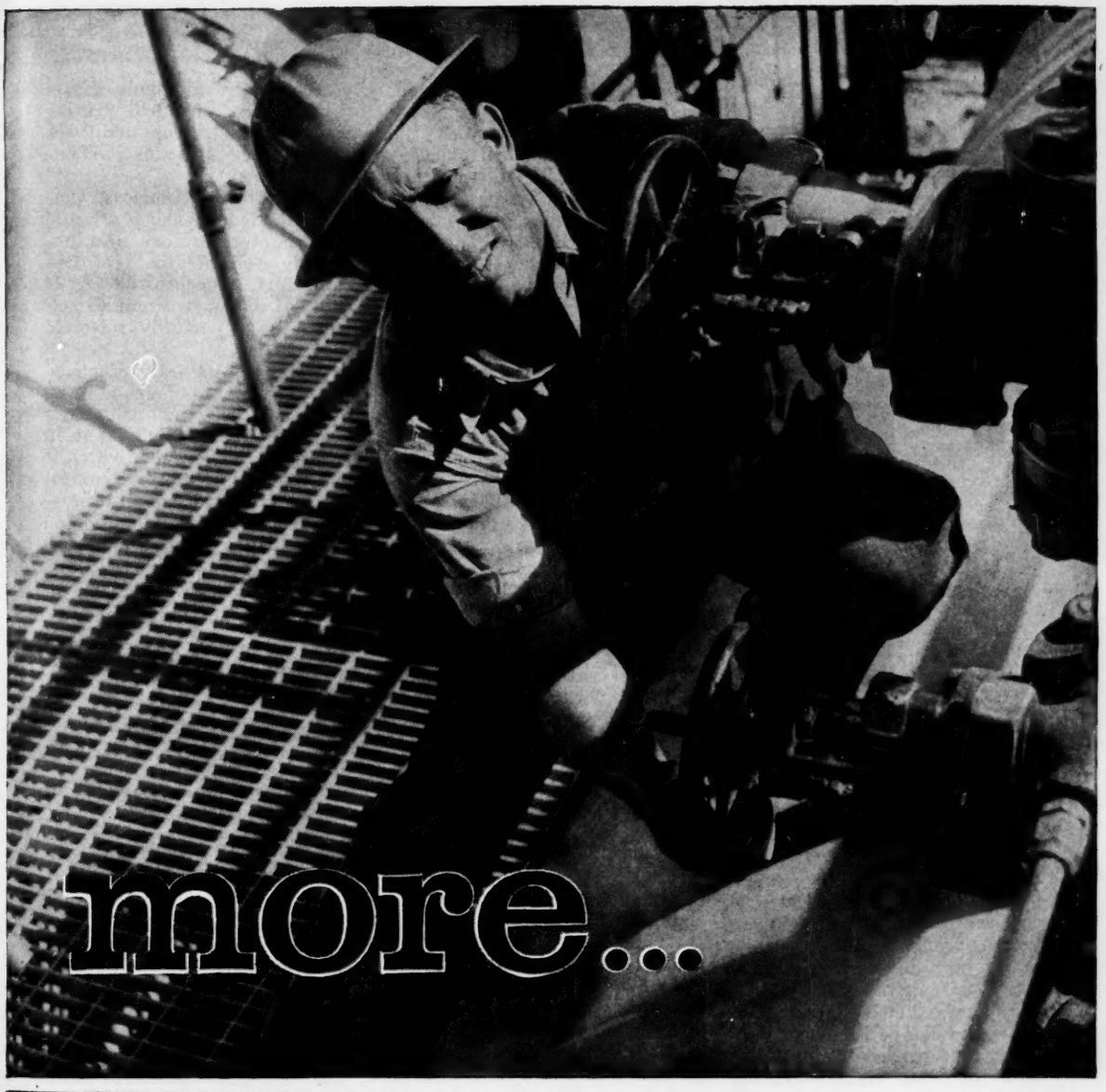
Chase Chemical Corp., Pittsburgh, Pa., has made available a two-component system that will foam, set and cure very quickly without the use of external heat or pressure. Called Nafil AR resin and Nafil HM catalyst, ingredients of the new system can produce, for example, a 2-lb./cu. ft. foam which will set in 5 min. and cure in 10 min. at room temperature. 178C

The system is expected to expand foam's use in production line items where fast cure, quick release and prompt handling are essential.

Cement Additive

Imparts greater strength to conventional ready-mix.

A water-reducing, air-entraining agent, new additive imparts strength to conventional ready-mix cement. Called Placewel, it is a liquid composed of amine salts of complex alkyl and aryl hydrocarbons, along with possible condensation products of unknown composition. Perfected after a year of testing in the Northeast, the product has just moved from the pilot plant to commercial production at Manville, N. J. — **Johns-Manville Corp., 22 East 40th St., New York, N. Y.** 178D



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NIACET vinyl acetate monomer

Trade-Mark

A large, new unit is now on stream at Texas City, Texas. This unit more than doubles existing capacity there and substantially increases national production of vinyl acetate monomer.

With this increased availability, you can count on CARBIDE to continue to meet your growing needs for vinyl acetate monomer. And you can rely on NIACET vinyl acetate monomer because it is produced by the pioneer and leader in vinyl monomers.

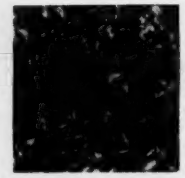
In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal.

The term "Niacet" is a registered trade-mark of Union Carbide and Carbon Corporation.

Coal-Derived Paraffin

New low-cost crystals . . .

are more like microcrystalline waxes . . .



are less like conventional paraffin waxes . . .

An exceptionally hard, high-melting point wax derived from coal has recently become available in the U.S. and Canada. Produced in a highly refined pure state at unusually low cost, it differs from conventional paraffin waxes primarily in its high temperature properties and crystal structure.

The crystal size is much finer and more like petroleum microcrystalline waxes. The melting point is much higher, 214 F., as compared to 150 F. for the upper limit of conventional paraffin waxes. Hardness is much greater, particularly at elevated temperatures where it is comparable to carnauba and candelilla.

These special properties, coupled with low cost of 15¢/lb. in carload lots, suggest use:

• As a chemical raw material. Purity and economy of the high molecular weight, long, essentially saturated straight chain hydrocarbon open a new field for chemical products heretofore not commercially possible. The new wax is an ideal chemical raw material or intermediate for further chemical processing, such as oxidation-esterification, chlorination, and sulfonation.

• As a petroleum wax modifier. It is an excellent opacifying agent and crystal modifier for paraffin wax. In paper coatings utilizing paraffin or microcrystalline waxes, it improves scuff, blocking, grease and dust resistance, hardness, tensile strength and gloss stability. It lowers friction (better slip of coated surface in contact with itself or processing machine), and decreases tack. Higher percentages provide coatings or impregnating agents with unusual high temperature characteristics—especially suitable for hot drink containers or hot packaging of food products.

• In plastic and rubber processing. It shows possibilities as a detackifier, lubricant, hardening or stiffening agent, and as a finishing aid to improve gloss and provide a smoother surface. When compounded with certain plastics, moisture vapor transmission characteristics of the latter are improved. The excellent electrical properties make it suitable for use in electrical potting and insulating compounds.

• In polish formulations. Excellent hardness characteristics, water resistance, ability to take on a high shine when buffed, plus Paraflint's price advantage over such waxes as carnauba, suggest its use in many polish formulations.

Called Paraflint, the wax is produced at South African Coal, Oil & Gas Co.'s (SASOL) new coal-based synthesis plant near Johannesburg (*Chem. Eng.*, Feb. 1956, p. 130). The Lurgi fixed-bed version of Fischer-Tropsch produces the wax which is now available in large quantities.—**Moore & Munger, 33 Rector St., New York 6, N. Y. 180A**

Alpha Olefin

Suggested uses in chemical synthesis, resins, polymers.

A mixture essentially of 1-hexadecene and 1-octadecene, a new alpha olefin product called Adecene 3877A is now commercially available. Suggested uses: chemical synthesis, resins, petroleum additives, textile processing aids, surfactant, polymers.

It is almost colorless, possesses little odor and is a liquid at room temperature. An unusually chemically reactive compound, Adecene 3877A is soluble in most organic solvents, only partially miscible in methanol.

Derived from fatty alcohols, the new alpha olefin will be processed in the company's year-old fatty alcohol plant in Ashtabula, Ohio, from which it may be had in tankcar, carlot and less carlot quantities.—**Archer-Daniels-Midland Co., Minneapolis, Minn. 180B**

Catalysts

Two potential Ziegler catalysts independently pilot-made.

Titanium trichloride and trimethyl aluminum, each considered a promising catalyst for the production of Ziegler low-pressure polyolefins, have gained pilot plant producers in recent weeks: USI for trimethyl aluminum, Stauffer for titanium trichloride.

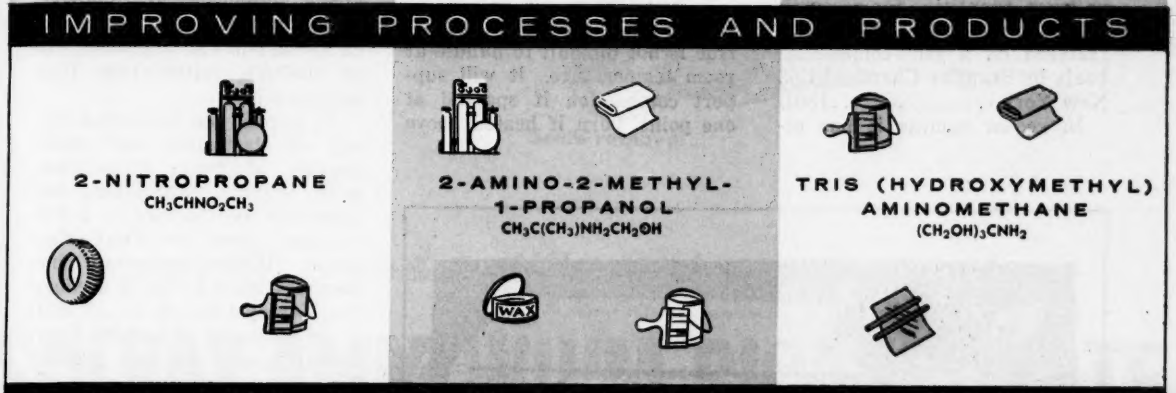
Trimethyl aluminum is being made at Laurel, Md., by U. S. Industrial Chemicals, New York. It has possible use as an intermediate for chemical synthesis as well as polymerization catalyst. A highly flammable liquid which ignites spontaneously in air, it is being tested as a fuel and ignitor for ram jet and turbo jet engines.....180C

Also available from USI's pilot plant is methyl aluminum sesquichloride, a mixture of methyl aluminum dichloride and dimethyl aluminum chloride. This, too, may find use as a catalyst or chemical intermediate.

A new sodium-based process is used for synthesis of trimethyl aluminum; the same basic process can be used to make other aluminum alkyls. One previous producer, Rocky Mountain Research, Inc., started up a commerical unit for trimethyl aluminum last year us-

CSC NITROPARAFFINS

IMPROVING PROCESSES AND PRODUCTS



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Nitroparaffins and their derivatives are economical, effective, versatile chemicals for such uses as solvents . . . prime ingredients . . . raw materials . . . sensitizers . . . emulsifiers . . . analytical reagents . . . reducing agents . . . inhibitors . . . short-stoppers . . . surface activants . . . dispersants . . . anti-foamants.

In a relatively short time, the members of the nitroparaffin family found wide use in many important industries.

New groups of derivatives are being studied continually for new and profitable applications. Steadily increasing quantities of these unusual chemicals are being shipped from CSC's plant in Sterlington, La.

Our Market Development team is ready to work with you in applying these outstanding products to your processes and products. Samples and technical data sheets are available on request.

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In Canada: Reliance Chemicals, Ltd., Montreal. *In Mexico:* Comsolmex, S. A., Mexico 11, D. F.

ing a process involving reduction of aluminum with a methyl radical carrier (*Chem. Eng.*, Aug. 1956, p. 108).

USI cost estimates, based on pilot operations, indicate that the trimethyl can be produced in commercial quantities for $2 to $5/lb., although the price in pilot quantities is considerably higher.

Titanium trichloride, previously obtainable only in ounce or gram quantities for research purposes, is now being manufactured on a semi-commercial basis by Stauffer Chemical Co., New York. 180D

In recent months it has attracted research attention because of its potential application as a catalyst for the manufacture of isotactic polymers such as polypropylene, polybutene and polystyrene. It has been cited in the literature as a promising catalyst for the production of Ziegler low-pressure polyethylene, of a new cis-polybutadiene rubber, and for use in Friedel-Crafts type reactions.

A fine, dark purple, crystalline powder of high purity, trichloride is not difficult to handle at room temperature. It will support combustion if sparked at one point, burn if heated above 400C. Because of its acidic nature, direct contact with the compound or its solutions should be avoided.

Single Can Holds Shipping-Container Temperature

A 1-qt. can of a new chemical compound, one of a new series collectively called Transit- Heet, has the ability to maintain an even temperature in a 800-cu. in. volume of an insulated package by releasing or absorbing 300 Btu. latent heat. Enclosed along with perishable contents in a shipping container, a can of one of the new compounds can keep the interior at any temperature between 40 and 120 F. for as long as the container is in transit.

The specific temperature desired is set by the manufacturers before Transit-Heet is packed in its sealed can by varying the formula and the chemical compound. Each can is re-usable but, after each trip, is must be "recharged" somewhat like luminescent paint must be allowed to soak up new light every so often. In summer, cans must be placed in a refrigerator for 12 hr.; in winter, in an oven.—Jet-Heet, Inc., Englewood, N. J. 182A

Vulcanizing Agents

Improved insoluble sulfur, plus new agent for fluorocarbon rubber.

A new vulcanizing agent, one aimed specifically at fluorocarbon rubber, and a new variation on an old one—an improved type of insoluble sulfur—have been announced.

To permit the controlled curing of elastomers and resins capable of being cross-linked with organic polyamines, and especially satisfactory as a vulcanizing agent for Kel-F elastomer, HMDA-Carbamate has been developed by M. W. Kellogg Co., Jersey City, N. J.....182B

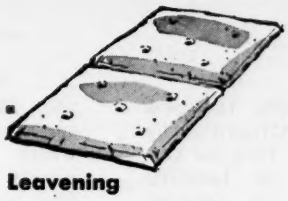
An inner salt of ω-amino hexyl carbamic acid, the new product also shows promise as an efficient curative for other rubbers of the reactive halogen or acrylic ester type. One of its primary advantages is that of controlled reactivity; the normally active amine groups are shielded until curative and polymer are thoroughly mixed. This shielding minimizes premature reactions due to localized, high concentrations of the curative during the early stages of mixing. The effect is a more uniform distribution of cross-links between elastomer molecules.

Compounds containing three parts of HMDA-Carbamate per hundred of Kel-F elastomer, along with metal oxides as modifiers, have been cured at 300 to 350 F. to produce vulcanizates having excellent physical properties, thermal stability and resistance to mineral acids, oils and fuels at elevated temperatures.

The new vulcanizing agent is a free flowing white powder which is readily soluble in water but insoluble in non-polar solvents.

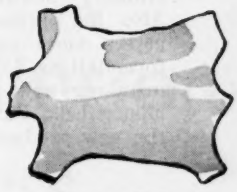
A new oil-treated grade of insoluble sulfur for use in rubber compounding has been developed by Stauffer Chemical Co., New York, N. Y. To be marketed under the company's

Biscuit baking...



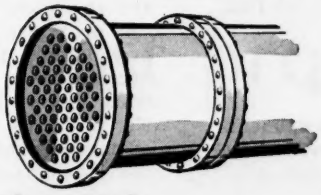
Leavening

leather tanning...



Neutralizing

gypsum removal...



Scale removal

each uses a different property of

SOLVAY AMMONIUM BICARBONATE

WHICH OF THESE PROPERTIES CAN YOU USE?

Physical and Chemical Properties

Molecular Weight: 79.06

Solubility in Water: 14% at 10°C., 17.4% at 20°C., and 21.3% at 30°C.—Insoluble in alcohol.

Negative heat of solution

Stability: Relatively stable at room temperatures.

Volatility increases sharply above 140°F.

Decomposition product ratios are as follows:

Ammonia gas (NH_3)	21.5%
Carbon dioxide gas (CO_2)	55.7%
Water vapor (H_2O)	22.8%

pH of 1/10 N solution at 25°C.: 7.8

Appearance: White Crystals

Quality: Exceptionally pure. Food grade.

Very low metal content.

The leavening of thin-baked goods, the neutralization of strong leather-making acids and the removal of gypsum from processing equipment are typical of the many and diverse processes that have adopted properties of SOLVAY Ammonium Bicarbonate. These properties include the economical and complete volatilization to a nontoxic gas at low temperatures and without residue. Its solutions have lower pH and yet greater neutralizing ability than certain competitive alkalies. It also provides a dry, crystalline source of ammonia for packaged cleaning compounds.

Whether your need ranges from a material to create voids, to mild neutralization of acids, or to a dry source of ammonia for household cleaning compounds—check the properties of SOLVAY Ammonia Bicarbonate.

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Ammonium Chloride • Methylene Chloride • Methyl Chloride
Ammonium Bicarbonate • Ortho-dichlorobenzene • Chloroform
Soda Ash • Monochlorobenzene • Carbon Tetrachloride • Para-dichlorobenzene
Chlorine • Cleaning Compounds • Hydrogen Peroxide

Crytex trade mark, the new grade has an extraordinarily low dusting level. This fire hazard encountered in handling ordinary sulfurs is reduced. Also, the oil-treated grade disperses more easily in rubber formulations. Stauffer is now installing new facilities at its Monogahela, Pa., plant to make the new product.....182C

Protective Lining

Guards metal components of chemical process systems against corrosion.

A new corrosion resistant lining material to protect the metal components of chemical process systems has been developed. A flexible thermoplastic, it shows extraordinary resistance to a broad range of acids, alkalis, salt solutions and solvents commonly found in storage tanks, processing tanks, medium to large diameter pipes and fittings, fume ducts and hoods.

Called Saraloy 898, it is an elastomeric copolymer based on vinylidene chloride. It is the first of a series of materials of this type which the company plans to make available.

Saraloy 898 is supplied in standard 37-in. by 133-in. sheets and in from ⅛-in. through ½-in. thicknesses. It can be readily installed in the field or in applicator's plant by employing a chemically resistant Saraloy 898 adhesive system. There is no need for vulcanization after the material has been applied. It has good strength and abrasion resistance, will not support combustion and has high elongation and flexibility. —**Dow Chemical Co., Midland, Mich.** 184A

BRIEFS

Greases for high temperature, based on molybdenum disulfide and a modified form of bentonite clay, have been developed in Britain. The series of greases is claimed to be capable of giving efficient lubrication at working pressures of the order of 100,000 psi. Therefore, its members can be used in machinery which is operating continuously at temperatures as high as 450 F.—**Rocol Ltd., Rocol House, Swillington near Leeds, Yorkshire, England.** 184B

Saturated terpene peroxides and their use in polymerization processes are covered by new patents assigned to the Secretary of Agriculture. Some claims in this patent, No. 2,775,578, cover the use of para-menthane peroxide in the production of synthetic rubber. It is believed that 700,000 tons of synthetic rubber are produced annually using para-menthane hydroperixide as the polymerization catalyst. These peroxides are also finding use in the curing of polyester resins and current production of saturated terpene hydroperoxides is in excess of 2 million lb./yr.—**Southern Regional Research Laboratory, U. S. Dept. of Agriculture, 1100 Robt. E. Lee Blvd., New Orleans, La.** 184C

Bactericidal, fungus-free, nontoxic paints, developed in England by Denton Edwards Ltd., have become available in the U. S. New additives for polyvinyl acetate paints result in two products tradenamed Bacti-cote and Fungicote. For process industries like food and pharmaceuticals requiring the ultimate in hygienic conditions, the new products can replace frequently-washed high gloss oil paints, which occasion high glare and condensation, or disinfectants, whose activity is short-lived and sometimes prohibitively toxic. — **Chas. Bowman & Co., 220 East 42nd St., New York.** 184D

Nonflammable solvents said to bite into and remove oil, grease, and dirt without harming delicate metal parts or electrical insulation, yet safe enough to use in ordinary work areas with conventional ventilating equipment are now being marketed under Du Pont's Freon trademark. Three types now available are: Freon MF, with a boiling point of 75 F.; Freon BF, which boils at 199 F.; Freon TF, whose boiling point is 118 F.—**Du Pont Co., Wilmington, Del.** 184E

Potassium silicate is now commercially available in two new grades: No. 28 recommended as an adhesive and binder for welding rod coatings, for special cements, and for other coatings; No. 40, more alkaline than No. 28, recommended for such additional applications as a builder for potash soaps and for rapid-sudsing soaps synthetic detergents normally prepared in liquid form.—**Cowles Chemical Co., 7016 Euclid Ave., Cleveland, Ohio.** 184F

Vitamin E in an improved dry form offers pharmaceutical manufacturers and food processors excellent stability, easier handling, ready dispersion in dry granular mixtures and powdered food supplements. It doesn't melt or liquefy at processing temperatures or when mixed with other vitamins to cause sticking and binding in tablet dies. Dry vitamin E acetate powder 25% contains 250 International Units of vitamin E per gram. — **Hoffmann-La Roche Inc., Nutley, N. J.** 184G

High purity beta sitosterol, finding a growing market in the treatment of arteriosclerosis, is now being produced in commercial quantities.—**Swift & Co., 1800-165th St., Hammond, Ind.** 184H

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard inside the back cover

Facing a problem common to many industries, this chemical plant had to clear up its wastes or pay. They installed Link-Belt treatment equipment, and today . . .

lick the high price of pollution with a low-cost process

To avoid Cincinnati's surcharges for industrial wastes, this company installed a waste removal system built around Link-Belt equipment. The highly effective system functions as an integral part of plant operations, keeping discharged water well within the city's purity requirements.

A Widespread Problem

Legislation of like intent is now in force in approximately three-fourths of the states. Each industry must find its own means to prevent pollution of dwindling water supplies.

The Cure Varies

Of course, waste composition and solids concentration determine the type of treatment required. In some plants, screening alone is adequate. A higher degree of treatment is needed in others where wastes contain highly toxic or putrescible elements.

What's the Answer?

An unbiased recommendation of treatment procedures requires a sanitary engineering source which manufactures a wide range of equipment. Such is Link-Belt Company—a major supplier of water, sewage and industrial waste treatment for over 35 years. And working with this broad line is a staff of experienced specialists—men willing and qualified to work with you, your chemists and consultants. Call the Link-Belt office nearest you for complete information. 14,500

TOMS RIVER-CINCINNATI CHEMICAL CORPORATION, Cincinnati Division, St. Bernard, Ohio. Link-Belt Circuline collector in 200,000-gal. settling tank. Beakers at right show waste water before and after treatment.

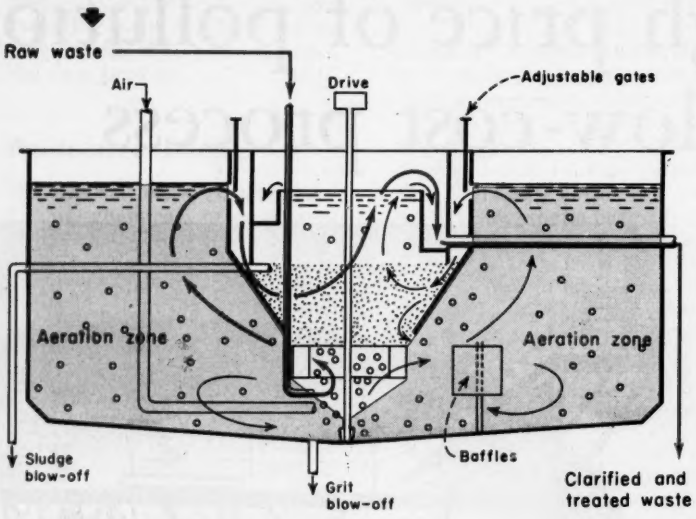
SETTLED SOLIDS extracted from waste water are concentrated into sludge, then dewatered and carried away by this Link-Belt 18-in. wide belt conveyor to be trucked to a dump. Link-Belt treatment and conveying equipment was recommended for the Toms River-Cincinnati installation by R. L. Woolpert Company of Dayton, consulting engineers.

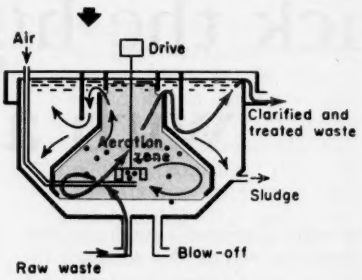
LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

New Bio-Oxidation Unit Lowers Cost by Novel Design Twist





By turning design inside out, Infilco adapts its activated-sludge system to treatment of high-BOD organic waste. Aeration volume is high compared to sludge-settling zone.

Treater Counters High BOD Waste Streams

Organic waste water with biochemical oxygen demand (BOD) greater than 600 ppm. can be treated effectively and economically in the new Infilco Type IO Aero-Accelator. Unit supplements the Type AR Aero-Accelator which handles waste streams with less than 600 ppm. BOD.

First Type IO unit will go on-stream this spring at Kalamazoo Paper Co., Kalamazoo, Mich. to handle 350 gpm. of deinking waste with a maximum of 1,000 ppm. 5-day BOD.

Another unit is planned for the Ferndale, Wash. refinery of General Petroleum Corp. to remove essentially all phenolics from a 510-gpm. waste flow containing 675 ppm. ultimate BOD.

Still other units are being considered for thiosulfate and furfuryl waste disposal. Typical of other waste streams that this system can treat are effluents from fruit and vegetable canneries, slaughter houses, milk and milk products, fermentation processes, textile mills and organic chemical plants. For the most part it's effective on any waste that is amenable to activated-sludge treatment.

▶**Economics Flip Design**—Reason for evolution of the IO design is rooted in the economics of size related to BOD of the waste stream. Type AR Systems can work effectively on waste rated higher than 600 BOD. But the size of AR equipment in this range involves greater expense than does the new IO equipment.

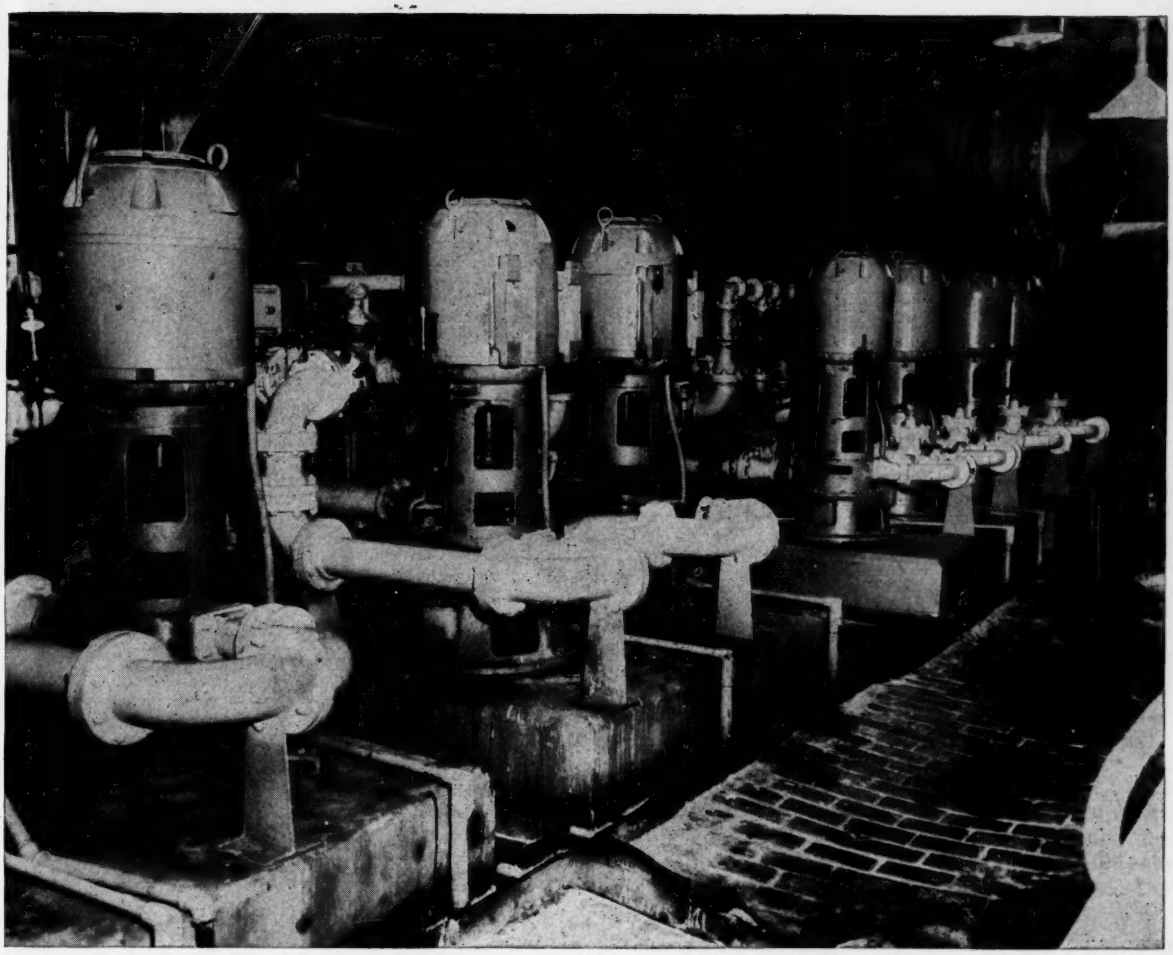
It's easy to see the reason for this when you realize that degree of aeration required during treatment increases directly with BOD. The higher the BOD, the larger the tank volume needed to provide the required aeration.

In the AR design, raw waste enters the center of the large circular tank, rises through an aeration zone, then descends outward through an annular space to a peripheral settling zone. For a high BOD stream, the aeration zone in the center of the tank is so large that the associated clarification zone on the periphery is much larger than needed for settling.

If clarification requirements are allowed to control design of the AR system, aeration volume is inadequate. Then, additional aeration tanks must be provided. Either way expense is greater than with the IO system.

▶**Center Feed and Discharge**—In the IO design, Infilco has reversed positions of aeration and clarification zones. Raw waste enters the bottom of the tank near the center. Baffles direct flow of waste and air outward from the disperser into a peripheral aeration zone.

Fully aerated material overflows inward down an annular space into the sludge zone. Clarified liquid from the top of this sludge zone overflows into a launder which is drained by



"Plant Down Time Was Materially Reduced"

During the first three years of operation, before the LaBour pumps were installed, this contact acid plant experienced frequent shut-downs. Because the pumps are under suction lift, handling up to 98% sulphuric at temperatures up to 85°C., it was considered normal when pump packing lasted a week and there were many times when repacking became necessary in a matter of hours.

In 1946 they replaced with LaBour Type G pumps, which are packingless, and their troubles were over. Four years later when they doubled the capacity of the plant they bought more LaBours. The original LaBours are still on the job, each pumping 150 gallons per minute around the clock.

You can profit from this experience. When your process depends upon the operating continuity of a pump, you need a LaBour—and when you need a LaBour, nothing else will do. Write for full information.

LABOUR

Equipment Developments This Month

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Process Equipment

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Centrifugal Pump 202B
Triplex Pump 202C
Spray Nozzle 202D
Water Filter 202E
Needle Valve 202F

Page number is also Reader Service code number

For more details, use Reader Service Card

pipe leading across the tank to the outside.

Since the aeration zone is in the peripheral position it can be sized for the job with complete flexibility. And since any enlargement is outward, the size of the clarification zone is not affected.

▶**Major Savings**—What this means in total size of the unit is illustrated by equipment recommended for the Kalamazoo deinking job. The unit being installed is a 42-ft. dia. IO basin. To do the same job with an AR design would require a 70-ft. dia. basin. Initial cost differential would be $20,000.

Comparison with trickling filters shows even greater savings. To reduce BOD 90% in a 500-gpm., 1,000-ppm.-BOD stream would require a 46-ft. dia., Type IO Aero-Accelator. Installed cost of such a unit, exclusive of piping, excavation and sludge-handling facilities, would be $125,000.

A trickling-filter installation for the same job would require two 100-ft. dia. filters and a 30-ft. dia. final clarifier. Installed cost for this equipment would run $165,000, exclusive of piping, excavation and sludge-handling facilities.

If the additional expense items were included the spread in cost would increase. The filter installation requires much more excavation and piping. And the piping is more complex.

Operating costs favor the filter because it uses only 1,450 kwh./day whereas, the Aero-Accelator needs 4,900 kwh./day. Other differences in operating costs are relatively insignificant.—**Infilco, Inc., Tucson, Ariz.** 186A

Drum Agitator

Inserts through bung, mixes contents well.

A new lightweight, portable mixer mounts easily in the threaded bung of a standard 55-gal. metal drum container. This model A agitator mixes drum contents thoroughly without damaging the drum.

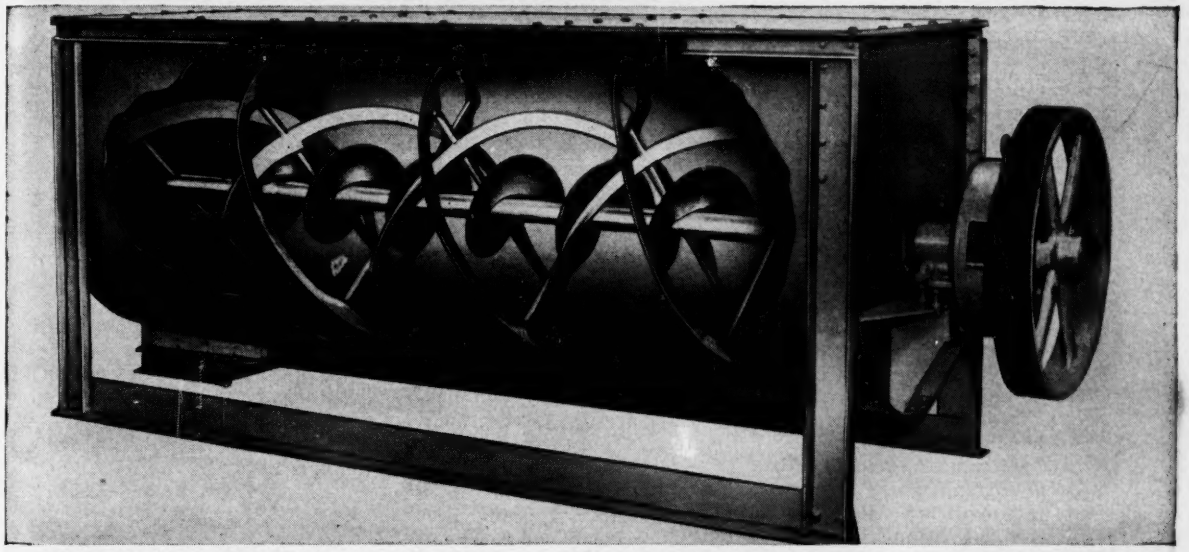
Unit consists of an electric drive motor, an aluminum mounting cage and a mixing shaft. Motor is a ⅓-hp. totally enclosed continuous operating design. Two small diameter mixing paddles are mounted on the shaft; one at the end, the other about half way up the shaft.

An explosion-proof model B also is available.—**Prenco Products, Inc., 507 East 10 Mile Rd., Hazel Pk., Mich.** 188A

Service Laboratory

Solves grinding, mixing and separating problems.

A customers' service laboratory established recently by the Strong-Scott Mfg. Co., Minneapolis, aims at helping chemical, food and feed processors



PRECISION MIXING WITH NEW TRIPLE ACTION MIXER

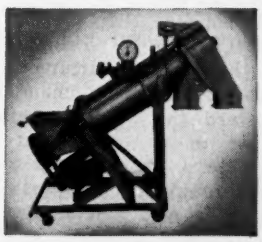
Strong-Scott Mixer Offers Uniform Blending and Mixing in 2 to 7 Minutes with 99.9% Thorough Distribution of Minor Additives.

Now, for the first time, a batch mixer with exclusive "Triple Action" mixing. The blending, folding and mixing action created by this unique triple ribbon and spiral assembly exposes each particle in the mixture to over 10,000 separate mixing actions per minute. The center spiral breaks and tumbles the core of the mix and moves the material to the outer 2 ribbons which convey the ingredients in opposite directions, subjecting each particle to thousands of mixing actions per minute. This produces a well balanced, uniformly mixed product of the highest efficiency known.

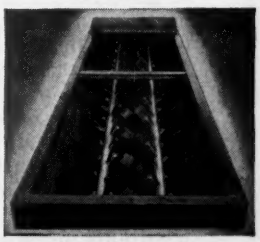
EXCLUSIVE FEATURE — Nylon seals between the tub and shaft, with outboard bearings. This permits cleaning in a matter of seconds . . . is sanitary, long wearing and dustproof. There is no hold up of product from one batch to the next.

The versatile design of the Triple Action Mixer permits feeding from any location at the top with single or multiple discharges to suit individual requirements. Hinged, drop-door bottoms for easy cleanout. Constructed of steel, stainless steel or commercial alloys.

Strong-Scott maintains a complete Customer Service Laboratory with a full line of standard equipment for your convenience, with no obligation to you. Consult Strong-Scott for additional details.



PORTA-BLEND—A portable dry mix and liquid blender capable of quality results at high capacity.



TWIN ROTOR MIXERS—Accurate blending of liquids and dry mix at high or slow speed.

WRITE FOR FREE COLOR BULLETIN

For complete information on the equipment shown above, write to The Strong-Scott Mfg. Co.

The Strong Scott Mfg. Co.

DEPT. CE-04

Equipment Designed for Better Processing

451 TAFT STREET, MINNEAPOLIS 13, MINNESOTA

solve their problems. Laboratory is geared to conduct tests and check operations using variable procedures to simulate unit operations in a broad number of industries.

Among the commerical machines found in the laboratory are an air-attrition impact pulverizer with internal air classification, a recently designed attrition mill utilizing standard motors, and a revolutionary hammer mill which permits use of hardened screens without danger of warpage.

Available on a no-charge basis, the laboratory services are conducted to demonstrate the top performance and feasibility of Strong-Scott's equipment.—**Strong-Scott Mfg. Co., 451 Taft St. NE, Minneapolis 13, Minn.** **188B**

Continuous Reactor

Laboratory size gives data for scale up.

Exact physical data for continuous processing in production size equipment can be obtained with the Experimenter laboratory size reactor.

Unit consists of series of cylindrical mixing chambers. Each chamber contains two mixing impellers separated by a baffle disk.

The first mixing impeller in each chamber moves a thin film of material outward across the heat transfer plate. When material reaches the outside of the plate, it goes over the disk baffle and is pulled by the second impeller back toward the center across the face of a second heat transfer plate.

Mixing is intimate throughout the unit and there is no possibility of short circuiting. Additives may be introduced at exactly the correct part of the reaction cycle. You can measure and control exothermic heat released during the reaction.

Normal throughput is between ½ and 50 gph., retention volume is 0.2 gal. Operating limits are: viscosity, 1 million centipoises; pressure, 1,000 psi.; temperature, 650 F.—**Marco Development Co., Inc., 815-25 West 5th St., Wilmington 1, Del.** **190A**

Ozone Generator

Has new power supply to triple output.

A new power supply now available for the Welsbach industrial model ozonators triples ozone output and cuts over-all plant cost.

Normal 60-cycle electric current is converted by the new power supply to 180-cycle current to operate the ozonator. By trebling the frequency, power input and ozonator output are trebled also, provided flow of air or oxygen and cooling water are increased proportionately.

Conversion efficiency of the new power supply is about 90%. Therefore, approximately 10% more electrical energy is needed to produce one pound of ozone than required when operating directly from a 60-cycle supply. However, with the increased output for a given unit, space and maintenance requirements are reduced two thirds. And over-all cost for larger ozone plants is substantially below cost of plants using 60-cycle power supplies.—**The Welsbach Corp., 1500 Walnut St., Philadelphia 2, Pa.** **190B**

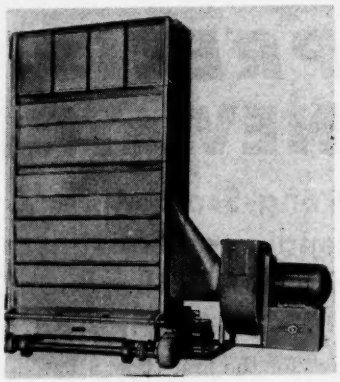
Blending Bin

For bulk solids, blends mixture continuously.

Free-flowing bulk solids with varying physical characteristics or chemical analysis may be blended to homogeneous mixtures on a continuous basis through use of a new method.

Material is blended in a metal or concrete bin which contains a series of overlapping baffles to deflect the solids outward to the sides of the container. Entering solids are layered into a rectangular bin by a conventional belt conveyor tripper or by a simple chute for a cylindrical bin.

A side-chute section carries material directly to the discharge outlet. Incoming material is directed into this chute in a continuous series of small increments from top to bottom. Blending takes place automatically as small portions of each layer enter the chute area and flow downward by gravity.—**Hewitt-Robins, Inc., Stamford, Conn.** **190C**



Pellet Cooler

Controls flow of pellets and air automatically.

A new pellet cooler and dryer is reported to be simple and effective, operating with a minimum of fines or dust leakage.

Pellets are spouted into a stainless-steel-lined hopper at the top of the cooler where a stainless-steel deflector splits them into two columns. Pellets flow by gravity on to a shaking shoe and then to the discharge chute. Rate of discharge is adjusted automatically to feed rate.

During flow downward, each column of pellets passes through a separate transverse air stream which gently and gradually cools the pellets. Exclusive hinged louvers insure efficient cooling of all pellets regardless of size of the run.—**Sprout, Waldron & Co., Inc., Muncy, Pa.** **190D**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard inside the back cover

Klingerit gaskets cost less

Whether you use sheet or ready cut gaskets — Klingerit Gaskets cost *less* . . . because they last longer. Recommended for high temperatures, pressure joints in Refineries and Chemical Plants, Klingerit Gaskets practically eliminate costly joint failures. Available in thicknesses of .008" to $\frac{1}{4}$" in sheet sizes 60" x 160" from many convenient sources.

"Klingerit" — Universally used sheet packing for super-heated and saturated steam, hydraulic pressures, compressed air, gases, chemicals, oils, spirits, and ammonia solvents.

"Klinger-Oilit" —Oil resistant sheet packing intended for use in oil refining and distributing as well as for use with methyl-chloride and sulphur dioxide.

"Klinger-Acidit" — Acid resisting sheet packing, produced especially to resist hot nitric, hydrochloric and sulphuric acids, as well as most other organic and inorganic acids.

"Klingerit 1000" — Wire reinforced sheet packing for extremely high temperatures.

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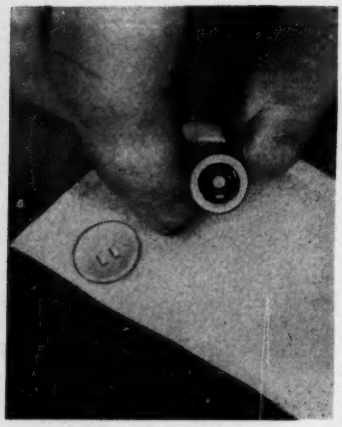


Electric Watch

First of its type, runs without winding or agitation.

Incorporating the first basic change in watch construction in almost 500 yr., a new electric watch is reported to be more accurate and dependable than any previous watch.

There is no mainspring in the watch. It will run for more than 12 months on energy supplied by a tiny energizer the size of a small shirt button.

Chemical energy within the energizer releases a stream of electrons through a coil of fine wire fixed on a balance wheel. Interaction between the electrical energy and permanent magnetic fields causes the balance wheel to oscillate and run the watch.

Development of the energizer was carried out in cooperation with National Carbon Co.— **Hamilton Watch Co., Lancaster, Pa.** 192A

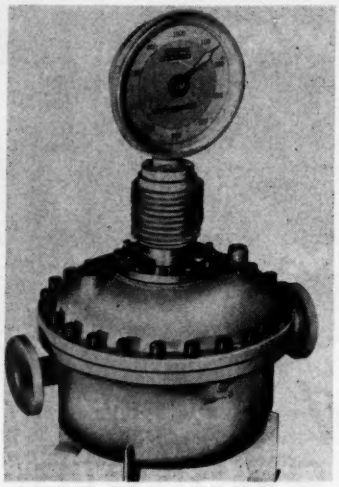
Pyrometer

Wall mounted unit checks surface temperatures.

An important addition to the field of surface temperature instrumentation is the type R-4200 wall-mounted pyrometer with flexible arm. Unit combines the convenience of a portable instrument with the protection of a wall-mounted device.

Use of this instrument enables a manufacturer with a battery of ovens, platens or molds to locate a surface instrument permanently at each station to check production temperatures. Bold numerals and sharp graduations make the scale easy to read accurately at a glance.

Instrument is available with a flexible arm and choice of ten thermocouples in standard Fahrenheit ranges from 0-300 to 0-2,000. — **Illinois Testing Laboratories, Inc., 420 North LaSalle St., Chicago 10, Ill.** 192B



Flow Meter

Positive displacement type for viscous liquids.

Newly added to the Brooks line is the VAF-Brooks flow meter for hard-to-handle liquids such as bunker oils, still bottoms and asphalt. Meter is highly accurate and can operate at elevated temperatures and pressures with high-viscosity fluids, either lubricating or non-lubricating.

Meter operates on the principle that the quantity of liquid displaced by each stroke of a piston is constant and the number of strokes may be integrated by a counting mechanism. In practice, the meter is fitted with four single-acting pistons arranged so that each piston controls the actions of the others. The pistons then act as sliding valves.

Meter body that houses the cylinders is made of a special heat-resistant meehanite iron and is enclosed in a steel steam jacket. No piston rings or glands are used. Piston and cylinders are fitted to close tolerances so that sealing occurs along the entire contacting surfaces.—**Brooks Rotameter Co., Lansdale, Pa.** 192C

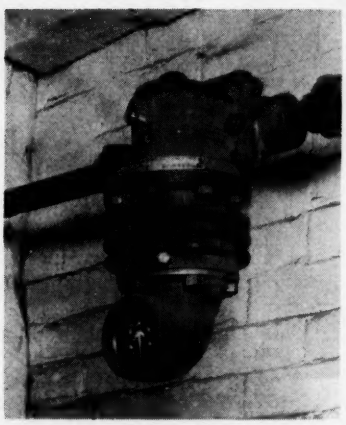
Flow Meter

For high pressure, has interchangeable parts.

A new flow meter for control of liquids and gases is rated at 15,000 psi. at 100 F.

Three interchangeable stainless-steel flow tubes with variable tapered orifices and floats permit up to 30 desired flow ranges from 0.1 ml. (min.) to 13 liters per min. (max.).

Interchangeable jackets can be obtained for jobs where meter must be heated while working. For working pressures from 50 to 1,000 psi., you can obtain increased flow ranges on custom order. — **C-Mar Corp., 35 Euclid Ave., Manasquan, N. J.** 192D

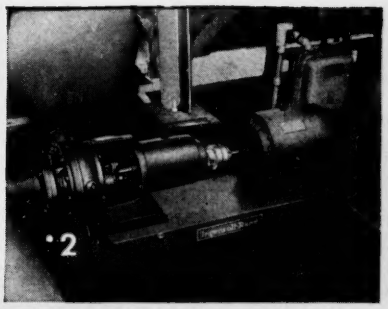


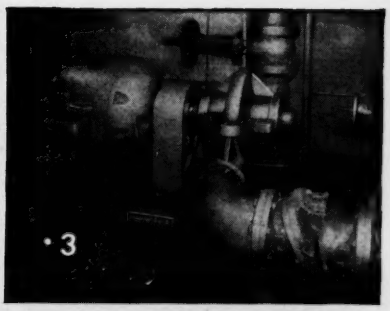
Steam Meter

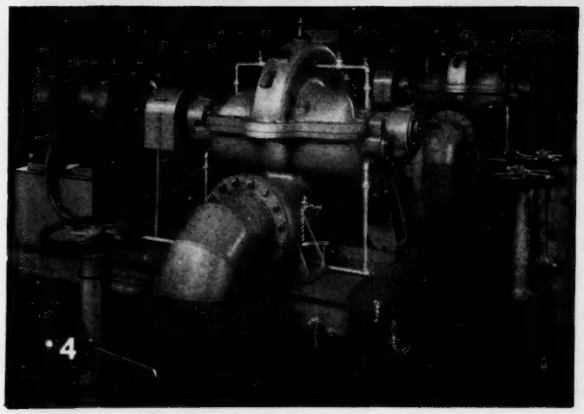
Incorporates changes for better operation.

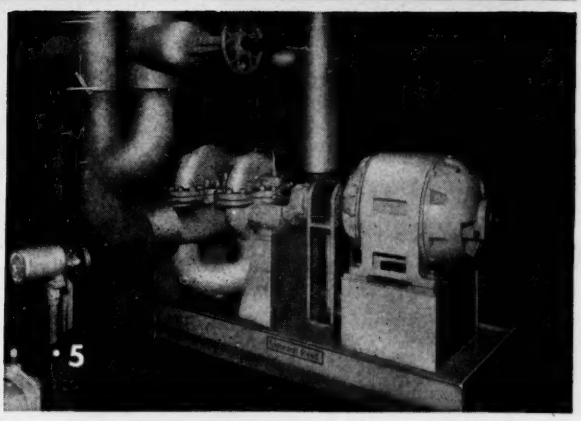
Several design changes have been announced for the model SMDH Shuntflo steam meter. From outward appearance, the most noticeable change is an advanced-design cooling chamber equipped with external cooling fins to keep the meter cool at all times.

From an operating standpoint, the most important









Five Keys to LONG-RANGE ECONOMY on your general-purpose pumping jobs

The Ingersoll-Rand pumps shown feature several different designs and types. Yet they all have one thing in common—the ability to give you low-cost performance on your general purpose pumping jobs.

When you install an I-R pump, you can count on continued efficient operation—with a minimum of time out for attention and maintenance.

In addition to the pumps shown, Ingersoll-Rand manufactures a complete line of single and multi-stage pumps of horizontal and vertical design for every job application. See your I-R representative for full information on the pump which best meets your needs.

1. MOTORPUMPS: Free from base plates, couplings and alignment problems, I-R Motorpumps can be mounted in any position that gives the simplest, most economical installation. They are especially designed for continuous full load service, with a wide range of capacities from 5 to 1800 gpm and heads up to 600 ft. Available in single, two and four-stage units.

2. CRADLE-MOUNTED PUMPS: Built with separate pump and drive units, coupled and mounted on a sturdy base plate, I-R Cradle-Mounted Pumps come in one and two stages, with capacities from 5 to 2800 gpm and heads up to 525 ft. They can be equipped with any drive, and provide easier accessibility, over-sized bearings and greater accessibility.

3. SINGLE-STAGE HORIZONTALLY-SPLIT PUMPS, with double mechanical shaft seals: For capacities from 275 to 2400 gpm and heads to 350 ft., maintenance-free DMV and DHV pumps are provided with double mechanical shaft-seals and permanently lubricated sealed bearings. Troublesome stuffing box maintenance is eliminated, and bearings do not require any attention or lubrication throughout the life of the pump.

4. SINGLE-STAGE HORIZONTALLY-SPLIT PUMPS, conventional design: The Class AFV unit illustrated is typical of the standard I-R line of single-stage horizontally-split centrifugals, with capacities ranging from 25 to 50,000 gpm, and heads from 20 to 350 ft. Stuffing boxes are extra deep, and equipped with water seal cages. Any type of drive may be used.

5. TWO-STAGE HORIZONTALLY-SPLIT PUMPS: I-R two-stage Class GT pumps are available in capacities up to 2200 gpm for discharge heads up to 1050 ft. Outstanding performance is assured by such features as extra deep stuffing boxes, renewable shaft sleeves and wearing rings, carefully designed liquid passages and volutes, and efficient closed-type impellers.

Ingersoll-Rand

10-455 **11 Broadway, New York 4, N. Y.**

PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES
COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS

change is that the meter body now accommodates a concentric orifice for sizing the meter. This orifice replaces the previous bypass plate and improves accuracy. In the model SMDH, style 57, orifices can be interchanged easier and no recalibration is needed.

Accuracy is plus or minus 2% of actual rate of flow over a flow range from 10 to 150% of rated capacity.—**Builders-Providence, Inc., Div. of B-I-F Industries, Inc., Providence, R. I.** 192E

Metering System

Provides automatic switch control right at meter.

A new explosion-proof control system for liquid metering systems provides for automatic switch control of all pumps and quantity control valves right at the meter. Upon completion of a predetermined delivery, a switch is thrown automatically to cut off liquid flow simultaneously at the meter and at the pump.

System includes a new accessory control switch, a predetermining register and latch box, and a quantity control valve—all installed at the meter. Where a fixed amount of liquid must be delivered repeatedly, a special factory-set predetermining register is available. This saves time by eliminating resetting of the register after each run.—**Meter & Valve Div., Rockwell Mfg. Co., 400 North Lexington Ave., Pittsburgh 8, Pa.** 194A

Gas-Cleaner Control

For Cottrell system, improves efficiency, lowers cost.

A new automatic feedback control for Research-Cottrell electrostatic gas cleaners eliminates the complexities, inefficiencies and cost of manually adjusting and controlling high voltage input.

Cottrell precipitators produce optimum results when input voltage and power are high enough to produce some sparkover between electrodes. The optimum point can be determined by experimenting with both precipitator and process.

Once determined, reference levels for current, voltage and sparking conditions at this point are set into the control. Then, on automatic operation the feedback loop compares actual current, voltage and sparking conditions in the precipitator with the preset reference levels.

Variations between actual and reference conditions are monitored continuously by the electronic control assembly. This assembly instantaneously determines and establishes rectifier output needed.

Units are compact and self-contained, can be installed directly on or near the precipitator to save high-voltage cable and floor space.—**Research-Cottrell, Inc., Bound Brook, N. J.** 194B

Analyzing System

Checks operation of steam-generating unit.

Operation of a giant steam-generating unit can be analyzed within a few hours through a new electronic system developed jointly by Babcock & Wilcox Co. and Bailey Meter Co. It will help engineers determine quickly and economically problems such as sources of heat losses, the most efficient types of fuels, and when and where to remove combustion waste deposits.

Through sensing elements linked to analog scanners, the system can probe hundreds of different boiler locations. At the touch of a button, system begins gathering data such as temperature, pressure and gas composition. Information is sorted electronically, supplemented with preset figures and punched on continuous tape.

Tape readings are transmitted by teletype to a large electronic computer in New York City. Translated automatically into code suitable for computer use, the information is processed and transmitted back to the boiler site for application by engineers and technicians.—**The Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.** 194C

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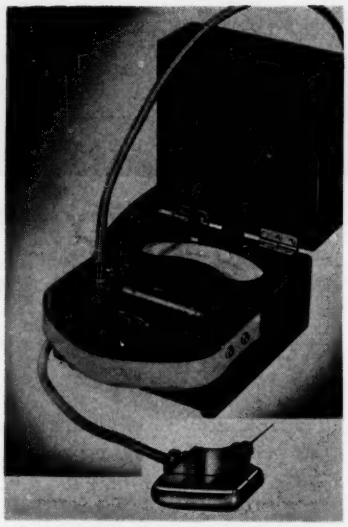

Pyrometer

Needle type gives quick reading inside material.

Just insert the needle into any material, and the internal temperature will be indicated on the dial of the Pyromajor pyrometer. Instrument will give quick internal temperatures for many materials, including rubber and plastic.

The stainless-steel hypodermic needle contains a rapid-response thermocouple and fine connecting wire. It is fitted with a pistol grip handle which connects through a 4-ft. armored cable to a mahogany case housing a 5-in. scale movement.

Standard ranges available are 0-100 C. and 0-200 C. A smaller model with 2½-in. scale movement also is available.—**Epic, Inc., 154 Nassau St., New York 38, N. Y.** 194D

TOMORROW'S PRODUCTS TODAY...THROUGH ENJAY PETROCHEMICALS

Basic ingredients for LACQUER finishes with that look of luxury!

Everyone admires those high-quality, high-gloss lacquer finishes on today's fine cars. Many manufacturers of these automobile lacquers specify Enjay solvents because of their purity, uniformity of boiling range and closely controlled evaporation rate.

And, Enjay solvents and ketones play an important role, too, in the formulation of many other surface coating products: lacquers, enamels and removers for paint, varnish and enamel.

The recently expanded Enjay Laboratories are fully equipped to handle any surface coating problem related to the application or use of any Enjay petrochemical. Why not write or call for more information?

Enjay offers a widely diversified line of petrochemicals for industry:

ALCOHOLS & SOLVENTS: Lower Alcohols, Oxo Alcohols, Ketones and Solvents; OIL & FUEL IMPROVERS: Detergent-Inhibitors, V-I improvers, Oxidation Inhibitors; CHEMICAL RAW MATERIALS: Olefins, Diolefins, Aromatics; ENJAY BUTYL RUBBER & VISTANEX.

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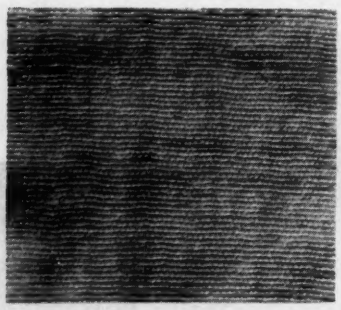
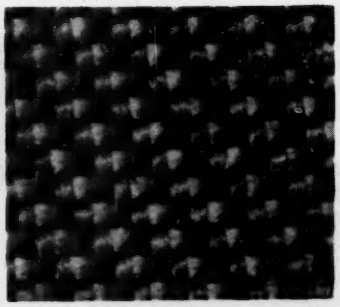
ENJAY COMPANY, INC., 15 W. 51st STREET, NEW YORK 19, N. Y. Akron, Boston, Chicago, Los Angeles, New Orleans, Tulsa





Filter Cloths Made From PVC

French fabrics constructed of 100% polyvinyl chloride fibers offer effective answers to many filtration problems.

Now available commercially in the United States are a range of polyvinyl chloride fabrics for industrial filtration. Here are the properties which make these fabrics interesting to filter operators:

- Do not swell in water.
- Tensile strength and elasticity not affected by water or most aqueous solutions.
- Stable to atmospheric and biological conditions.
- Not affected by concentrated acids, concentrated alkalis, detergents, oxidants, salts, aliphatic hydrocarbons and alcohols.
- Abrasion resistance exceeded only by nylon and dacron.
- Can be unplugged by washing with reagents.

▶ **Choose Your Fiber**—Fabrics of 100% polyvinyl chloride are woven with either continuous filament or staple fiber, and either with or without heat set. Rhovyl is the continuous multifilament which ranges from 75 to 1,600 denier. Fibravyl is the staple fiber made from Rhovyl in different staple lengths and deniers from 1.5 to 6.4.

Rhovyl and Fibravyl start to shrink at approximately 158 F. This trait is used to good advantage, particularly in air filtration.

Cloth is woven with a low denier multi-filament Rhovyl yarn and is then finished by a thermal process which shrinks the fabric. The resultant fabric has very fine mesh openings which can only be obtained by this procedure, it is said.

Removal of dirt or dust particles from air is facilitated by electrostatic charges which build up on the fabric and hold the particles.

▶ **Heat-Resistant Type**—A third type of 100% polyvinyl-chloride fiber, Thermovyl, is more resistant to heat than Rhovyl or Fibravyl. During spinning of Thermovyl, molecular orientation is modified so that the shrinking point is raised to 212 F. Simultaneously, tensile strength is reduced from 3.8 to 1.0 gm./denier.

In addition to using these PVC yarns in woven form, you also can use them as linters, wadding, flock or non-wovens. Filter media can be formed at the point of application by dispersing the flock and using it as a precoat.—**Rhodia, Inc., 60 East 56th St., New York 22, N. Y.** **196A**

Metal Laminates

Layers of two or three metals permanently bonded.

New metal laminates now available are combinations of two or three metals metallurgically bonded together to form one permanent sandwich. Resulting laminates offer physical, chemical and mechanical properties which are impossible to get in a single metal.

In addition to having high bonded shear strength, laminates resist dual corrosion. And over-all cost of the laminate often is less than the cost of a sheet of expensive metal.

Possible combinations include stainless and mild steels, Monel, copper, brass, titanium, and many other metals. — **Bridgeport Brass Co., 30 Grand St., Bridgeport 2, Conn.** **196B**

Non-Skid Grating

Abrasive grains in top surfaces prevent skiding.

Developed to protect permanently against slippery plant conditions, Relgrit grating retains the many advantages of open flooring yet provides absolutely sure footing.

A non-absorbent abrasive is baked into V-shaped openings along the top edges of the grating bars.

Permanent, non-skid surface produced by the grains is reported exceptionally effective whether wet or dry, muddy or oil soaked. It is not attacked by most commonly used acids, alkalis or chemicals. Wear resistance is two to three times that of steel. — **Reliance Steel Products Co., McKeesport, Pa.** **196C**

Equipment Cost Indexes

	Sept. 1956	Dec. 1956
Industry		
Avg. of all	211.3	218.3
Process Industries		
Cement mfg.	201.6	208.6
Chemical	211.5	218.8
Clay products	195.8	202.6
Glass mfg.	199.8	206.7
Paint mfg.	203.5	210.5
Paper mfg.	203.8	210.9
Petroleum ind.	207.7	214.9
Rubber ind.	210.3	217.6
Process ind. avg.	209.0	216.2
Related Industries		
Elec. power equip.	213.4	220.8
Mining, milling	212.8	220.2
Refrigerating	237.3	245.9
Steam power	199.2	206.1

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1957, pp. 266-7 for annual averages since 1913.

SAVE ON TOWER MAINTENANCE

PACK WITH LAPP PORCELAIN RASCHIG RINGS

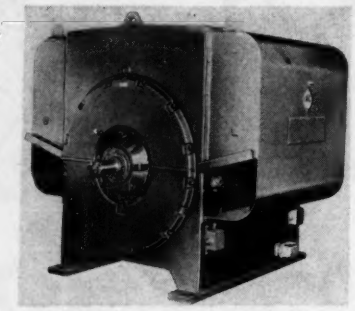
Lapp raschig rings are smooth, completely vitrified, strictly non-porous and iron free. They are chemically inert to acids of all concentrations (except hydrofluoric); there can be no crumbling from capillary pressures nor absorption of liquids to contaminate later processing. This combination of characteristics assures an indefinite life chemically. Physically, Lapp raschig rings are tougher against damage from handling and tower operation than other ceramic rings or other packing shapes.

Lapp customers report longer continuous service and greater purity of product from their Lapp packed towers . . . with greatly reduced maintenance costs.

WRITE for our bulletin describing the characteristics of Lapp Chemical Porcelain. See how you can save with a trouble-free system of Lapp Porcelain. Lapp Insulator Co., Inc., Process Equipment Division, 380 Wendell St., Le Roy, New York.

Lapp
CHEMICAL
PORCELAIN

XUM



Protected Motor

Designed for non-hazardous outdoor installations.

Weather - protected motor, type FOD, now is available in ratings of 250 hp. and larger for non-hazardous outdoor installations.

Motor is built into a rigidly constructed fabricated - steel frame equipped with two removable air ducts. Frame houses a removable pre-wound stator assembly unit. Stator leads, completely enclosed and protected, are brought to a diagonally split cast-iron conduit box. Capsule-mounted sleeve bearings supported by cast-iron brackets close end of frame.

Heavy steel removable air intake ducts have openings at each end. Design minimizes the effects of high-velocity winds and entrance of entrained moisture and particles into the electrical parts of the machine. Gutters above the openings prevent water from falling into the air intake stream.—**Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.** 198A

Conveyor-Roll Bearing

Mounted on stud allows easy replacement.

Maintenance and replacement costs on rolls and return idlers for belt conveyors are claimed lower with a new stud and bearing assembly. Conveyor roller shaft turns in ball bearings which are mounted on the removable studs.

All maintenance is done at the conveyor. Damaged or worn studs are removed and replaced with new stud and bearing assemblies. Then, the roller shaft is slipped into place and the job is finished.

Useful life of the bearing in the stud is exceptional since all rolls are machined to the proper internal clearance and the bearings mounted in line with two running rolls.

Stocks of studs and rollers of proper shaft size and fit include diameters from 2⅜ to 4 in. and lengths from 12 to over 36 in. — **Bearings, Inc., 3634 Euclid Ave., Cleveland 15, Ohio.** 198B

High-Voltage Starters

Increase overload and short circuit protection.

A new line of high-voltage combination starters for squirrel-cage, wound-rotor and synchronous motors combines the advantages of current-limiting, high-interrupting-capacity fuses with rugged air-break contactors. This means increased overload and short-circuit protection.

These and other features simplify the problems of controlling motor-starter load and maintenance in the face of greater circuit capacities.

Features of FPA combination starter include a completely enclosed steel fuse compartment, individual fuse isolation by full depth phase barriers, electrical series door interlock with automatic circuit opener, removable contact barrier with assembly access from front or rear, and insured separation of compartments through flanged door housings.—**Federal Pacific Electric Co., 888 North Keyser Ave., Scranton, Pa.** 198C

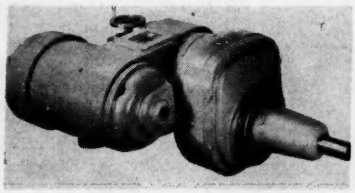
Truck Battery

Greater power, costs less to own and operate.

Through use of a new type porous tubing to encase the grid spines and active material of the positive battery plates, Exide Ironclad Giant Type GN battery offers the highest ampere-hour per cu. in. rating. Rated capacity is 72 ampere-hours per positive plate contrasted with 50 for the older type TLM battery and 60 for the newer TH Exide-Ironclad.

New tubing used in these batteries is highly permeable to the diffusion of electrolyte and the passage of current. This makes the batteries particularly effective at high discharge rates.

Although porosity is extremely high, the minute openings still prevent particles from working through. Thus space within the battery is used most effectively and the high capacity is preserved for long working life.—**Dept. TG, Exide Industrial Div., The Electric Storage Battery Co., Box 8109, Philadelphia 1, Pa.** 198D



Variable-Speed Motor

Now designed to handle greater radial loads.

New Slo-Speed gear motors and Speed-Trol variable-speed motors with reducer have been developed for severe radial load duty. Design relies on an extended bearing on the speed reducer. Distance between bearings on the output shaft has been lengthened to increase both radial load capacity and rigidity.

Many ingenious applications are possible now because this innovation minimizes need for secondary support bearings. On agitator drives, a rigid coupling now can connect the reducer shaft directly to the paddle shaft. The hard-to-clean pilot bearing can be omitted. And on chain-drives, sprockets can be mounted a greater distance out from the mounting feet than ever before.

Ratings now available, and others on the drawing board, will complete the line through 15 hp. All standard AGMA speeds are furnished from 350 through 20 rpm. in both constant and variable-speed models.—**Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.** 198E

See What Square D's Front-Connected *POWER-STYLE* Switchboards Offer!

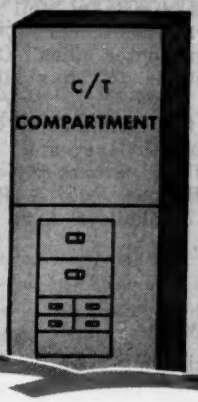
NEW!

First *completely standardized* switchboard built specifically for small and medium-size installations. Bus bars designed to assure *cool operation in a depth of 14 inches!*

Complete *front accessibility* allows all bus bars and branch circuit connections to be installed and removed *from the front!* Permits mounting directly against wall.

Off-center mounting of breakers (or QMB fusible switches) in right hand section provides maximum room for installing cables from larger units.

Standardized C/T compartment built to meet Edison Electric Institute and Public Utilities' specifications.



Completely standardized horizontal bussing is available up to 2000 amperes, at either top or bottom. Notice bus bar drillings for extension to future sections.

Standardized C/T compartment designed to provide most flexible arrangement. Available in either "hot" or "cold" sequence, top or bottom feed. When used without main disconnect in "hot" sequence, up to six subdivisions can be mounted in same section with C/T compartment.

Write for descriptive bulletin
Address Square D Company, 6060 Rivard Street, Detroit 11, Michigan

SQUARE D COMPANY

Multiwall Bags

Have foil interliner to block moisture, odor or gas.

Products shipped in the new Foil-Wall line of multiwall sacks receive maximum protection against moisture, odor and gases. Now a standard part of manufacturer's line, cost of the new sack is only slightly higher than polyethylene-walled bags. Yet, the protection against moisture vapor is 3 or 4 times greater than with polyethylene.

In standard form, the Foil-Wall sack will have a laminated sheet of 0.0035-in. foil and 40-lb. kraft positioned between inner and outer plies. Other constructions to be available include polyethylene extruded on foil, foil laminated to kraft with polyethylene and bags with foil in various ply positions.—**Hudson Pulp & Paper Corp., 477 Madison Ave., New York 22, N. Y.** 200A

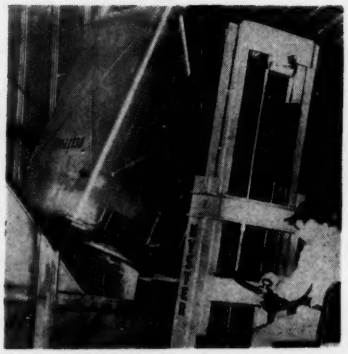
Conveyor

Oscillating type for intermediate capacity range.

Oscillating conveyors for a broad range of capacities and conditions now are available from Link-Belt with addition of the Coilmount model to its line. Designed for intermediate ranges and capacities, Coilmount supplements the light-duty Flexmount and the heavy duty Torqmount conveyors.

In design, Coilmount oscillating conveyors are similar to Flexmount and Torqmount except that the conveying trough is supported by cast aluminum rocker legs and coil springs. Motion is imparted to material in the trough by a constant-stroke eccentric drive that produces an upward and forward oscillating movement.

Available from stock, conveyors come in fully assembled sections of 5 to 10-ft. lengths, in trough widths of 10 and 20 in., 10 gage or $\frac{3}{16}$-in. trough thickness. Sections can be assembled in lengths up to 100 ft. —**Link-Belt Co., Prudential Pl., Chicago 1, Ill.** 200B



Unit Container

Portable steel bin offers freight-rate gains.

Bulk-handling costs incurred in storing and shipping granular or powdered materials can be cut appreciably through use of the new Deltainer portable steel bin. Savings ranging from \$3-\$15/ton on purchased commodities are possible by buying bulk quantities and using the new equipment for delivery.

Through incorporation of the Deltainer bin in a special railway car developed by Shippers' Car Line, a revolutionary new freight-rate system has been obtained. The entire Eastern Div., Assoc. of American Railroads and many of its Western Div. members have approved the Deltainer as a removable, but integral part of the special car. Thus, users will pay freight only on the net content of the containers, and not on the containers themselves.

Three Deltainer sizes are available. Food Machinery & Chemical Corp.'s Westvaco Mineral Products Div., co-developers of the system, currently uses 600-lb. tare weight with 65-cu.-ft. volume rated for 5,000 lb. loading. Other sizes with the same load-rating for different density solids are 36 and 88 cu. ft.

Bins are equipped with one 22-in. top center opening. A standard drum lid and bolted ring closes and hermetically seals this opening.—**Delta Tank Mfg. Co., Inc., Baton Rouge, La.** 200C

Belt Conveyor

New design maintains perfect alignment of steel web.

Perfect belt alignment and reduced initial cost are reported for the new Tru-Track steel-belt conveyor.

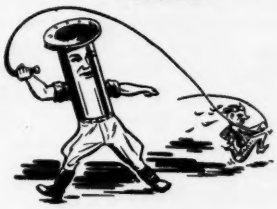
In the new design, V-ropes are bonded lengthwise to the underside of the standard Sandvik steel belt. These V-ropes travel over sheaves to provide positive tracking control.

Standard V-rope sheaves used with this design eliminate need for the more expensive crowned pulleys used formerly. Also, eliminated are guide rollers, pulley scrapers and return-strand scrapers. All these changes mean lower initial cost. —**Sandvik Steel Belt Conveyors, Div. of Sandvik Steel, Inc., 1702 Nevins Rd., Fair Lawn, N. J.** 200D

Polyethylene bottle for foods, pharmaceuticals and cosmetics can withstand sterilization at 250 F. for 30 min. Div. of Pharmacology of USFDA states it is considered acceptable as a container or package for above products.—**Plastic Container Div., Continental Can Co., 2930 North Ashland Ave., Chicago 13, Ill.** 200E

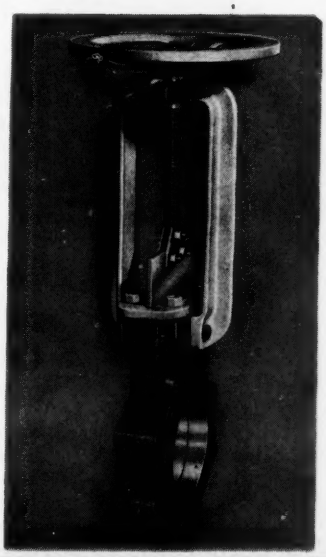
Polyethylene closure for ICC 2-S molded polyethylene drums became standard February 1, 1957 for 15, 30 and 55-gal. drums and optional for the 5-gal. drum. New closure eliminates possible damage to flange and threads, extends drum life because plug is replaced simply.—**Delaware Barrel & Drum Co., Wilmington, Del.** 200F

FOR INDUSTRIAL
and CHEMICAL PROCESS PLANTS
and plumbing installations



Whips Corrosion

*CNI MEANS CAST CHROME NICKEL IRON ALLOY



Since 1928 Attalla C N I has been whipping the corrosive effects of caustic, brine and concentrated sulphuric acid as well as many other destructive liquids and gases.

Attalla C N I's inherent properties of strength and resistance to corrosion and erosion make the use of expensive high alloys unnecessary in many industrial applications. The test of time has proven the performance, economy and durability of Attalla C N I.

Because of C N I's resistance to black liquor and caustic solutions, Streed Products Corporation, Gadsden, Alabama, has chosen Attalla C N I castings for the hand wheel, yoke, packing gland and body of a recently developed stock valve for pulp and paper mills, as shown. Attalla Pipe and Foundry casting technique and equipment assure quality and economical production of these special parts.

Write to our engineering department for further information and let them tell you of the many uses of Attalla C N I and its application to your specific problem.

ATTALLA PIPE AND FOUNDRY COMPANY, Inc.
P. O. Box 211 · · · Telephone 2211
ATTALLA, ALABAMA

Axial Compressor

Operates efficiently over extended range.

Full control of stator blades on a new model axial compressor extends the range of high-efficiency operation. Capacity can be varied almost as readily as with centrifugal compressors. Yet machine still maintains high efficiency and pressure rises at part load points which are characteristic of the axial compressor.

Each row of stator blades is positioned by a hydraulic master positioner or electric motor through gearing. Generally, individual rows are tied together so that all are adjusted simultaneously. However, for fine control, the rows may be adjusted individually. — **Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.** 202A

Centrifugal Pump

Standard, close-coupled type available from stock.

Pump users who wish to save both space and investment should investigate the Type GSC, standard, close-coupled centrifugal pump. Units are designed to handle a wide range of general applications that do not necessarily require a more costly engineered pump.

Line comprises seven pumps with capacity up to 600 gpm. and total dynamic head up to 275 ft. Liquids can be pumped over a temperature range from −40 to 250 F. Three standard material classifications are bronze fitted, all iron and all bronze. — **Dean Bros. Pumps, Inc., 323 West 10th St., Indianapolis 7, Ind.** 202B

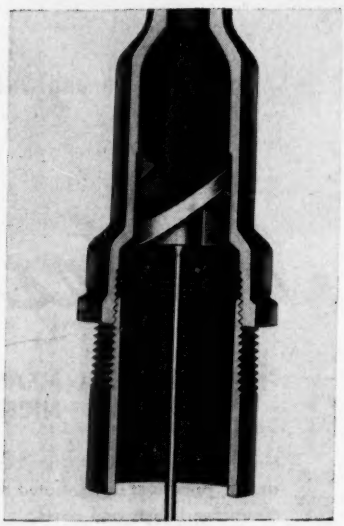
Triplex Pump

For corrosive viscous slurries at medium pressure.

Basic improvements incorporated in a new, sanitary, triplex pump are said to solve many problems in pumping corrosive slurries as viscous as 40,000 centipoises at medium pressures.

Standard design of the pump may be varied to meet individual service conditions. Materials of construction and the drive may be specified by the customer; plungers may be equipped with packing, cups or O-rings; a ceramic or special alloys may be used rather than standard Stellite valve trim; flanged or sanitary connections may be employed, and higher pressures can be accommodated at reduced displacements.

Maximum capacities range from 10 to 30 gpm.; maximum pressures from 450 to 1,500 psig. and maximum recommended speed 150 rpm.—**The Girdler Co., 224 East Broadway, Louisville 1, Ky.** 202C



Spray Nozzle

Has removable vane for easy cleaning in place.

To simplify cleaning of spray nozzles in hard-to-get-at places a new Fulljet nozzle is available with pull-out vane. A small female threaded connection in the vane receives a pull-out rod installed by the user.

Length of this rod can be selected so that it extends back inside the pipe to some connection point that is easily accessible. When nozzle requires cleaning, the vane is merely drawn back through the pipe, removed and cleaned. Nozzle itself is flushed out before the vane is returned — **Spraying Systems Co., 3275 Randolph St., Bellwood, Ill.** 202D

Water Filter

Removes particles as fine as 0.45 microns.

Filtering up to 400 gph., the MF Submicron filter brings to production scale a filtering technique that hitherto has been possible only on a very small scale in bacteriological and analytical laboratories. It removes submicroscopic particulate matter that is found even in highly purified water. And the unit can be used only on such pure feed because even clear tap water will clog it quickly.

Filter consists of carefully machined heavy bronze filter plates clamped together by means of large wing nuts. A pure nickel screen supports the Millipore filtering membrane against liquid pressure.

Membrane is a cellulose ester disk approximately 150-microns thick with total pore volume of 80 to 85%. Providing quantitative retention of all particles larger than 0.45 micron, the disk produces a pressure drop less than 0.3 psi. at 100 gph. when clean.—**Barnstead Still & Sterilizer Co., 2 Lanesville Ter., Boston 31, Mass.** 202E

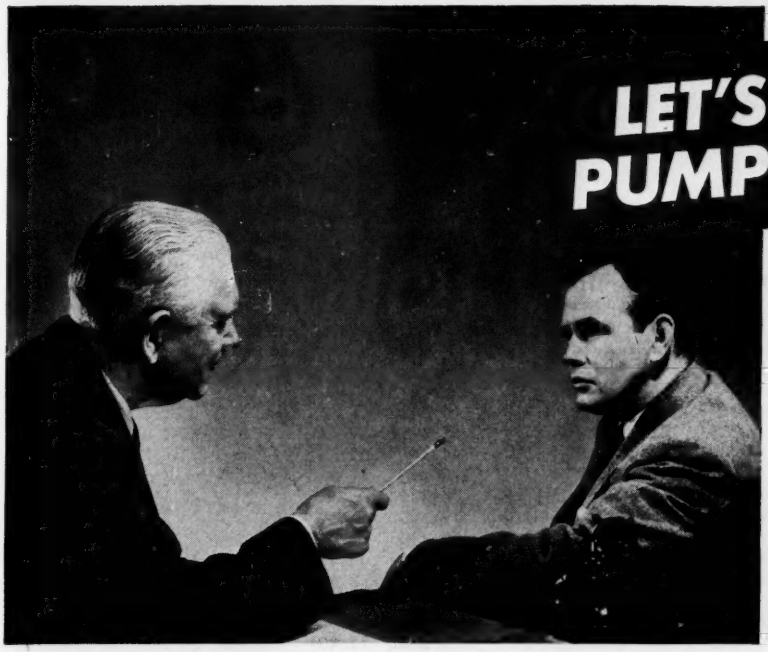
Needle Valve

Bubble-tight design for corrosive service.

Chemtrol's new bubble-tight needle valve meets the exacting requirements of fluid systems where corrosion is a problem. The Kel-F needle seals against a low-friction Quad-Ring. Virtually wearproof sealing is assured for high or low pressure and vacuum.

These valves do not stick or gall. A micrometer adjustment couples the calibrated body and indicator handle to fine threads that position the needle.

Chemtrol needle valves are available in ⅜- and ½-in. female pipe sizes and ⅜-, ½-, and ⅝-in. O. D. male tube connections. They operate at temperatures up to 170 F. and up to 170 psi. or higher for intermittent duty. —**Chemtrol Corp., 1513 West El Segundo Blvd., Compton, Calif.** 202F



LET'S EXAMINE PUMPING COSTS!

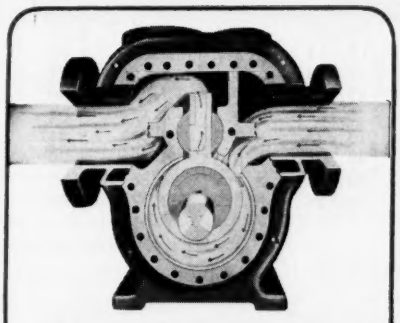
What Penalties Do You Suffer in Moving Semi-Solids and Viscous Materials?

If you buy pumps on the basis of capacity, horsepower input and the price tag—this message is for you 100%. Pumping costs for handling "hard-to-pump" substances cover a wide range of considerations if the true economy picture is to be exposed—first cost can be very misleading. For instance: time lost getting material up to a pumpable temperature can cost you more than the pump. Steam-jacketed KINNEY Pumps operate efficiently at substantially lower temperatures. Making plant changes, to accommodate a "price" pump with inadequate suction efficiency, can be costly. Where the pumping problem is not "run of the mine," the sound approach is to know all the facts about

Kinney®

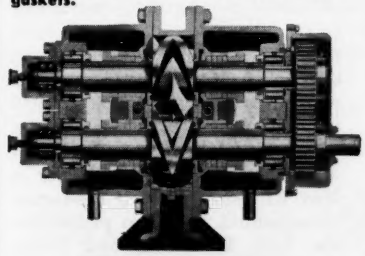
ROTARY PISTON and HELIQUAD PUMPS

KINNEY Pumps afford you a virtual "prescription" selection to accommodate your pumping requirements. KINNEY Heliquad Pumps give greater suction lift than other pumps for two very sound reasons: 1. The chamber for entrance of material to the pumping area is large, open and unimpeded, 2. The rotor design develops larger openings to suck in and expel the fluid. And, KINNEY provides a selection of Heliquad rotors in configurations which adapt the design to the material pumped. KINNEY Pumps are the economical answer to hundreds of "sticky" production problems. They're not cheap . . . they just save money!



ROTARY PISTON PUMPS

Rotary, positive displacement type with displacements ranging from 1½ to 3,000 gpm for working pressures of 70 to 250 psi. Plain and steam-jacketed models. Handles wide variety of substances and can be used for metered delivery. Extremely high vacuum characteristics. No valves, springs or gaskets.



HELIQUAD PUMPS

Deliver continuous non-pulsating flow of liquid—viscous or non-viscous—ranging from gasoline to blackstrap molasses. Plain and steam-jacketed models. Selection of Heliquad rotors provides pumping design best adapted to the substance to be handled. Capacities to 2500 gpm, working pressures to 350 psi.

WRITE today for your copy of Bulletin No. L-54.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
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Kindly send me Bulletin No. L-54 describing KINNEY Rotary Piston and Heliquad Pumps.

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Chemical Processing Profits—Big Firms Stub Their Toes

	Sales (Thousand Dollars)			Post-Tax Net Profits (Thousand Dollars)			Earnings/Share (Dollars)	
	1956	1955	% Change	1956	1955	% Change	1956	1955
Air Reduction	169,819	149,232	+13.8	15,732	11,569	+36.0	4.32	3.54
Allied Chemical & Dye	668,938	628,514	+ 6.4	47,005	52,128	− 9.8	4.88	5.45
American Cyanamid*	500,000	451,088	+11.0	44,247	35,700	+14.3	4.21	4.07
American Marietta	202,311	165,340	+22.4	16,205	11,110	+45.9	3.59	2.91
Atlas Powder	67,080	60,341	+11.2	4,206	3,480	+20.9	5.61	4.70
Celanese*	185,000	177,502	+ 4.2	12,390	15,303	−19.0	1.35	1.82
Diamond Alkali	121,250	110,292	+ 9.9	10,380	8,443	+22.9	3.83	3.11
Dow Chemical†	307,310	272,971	+12.6	24,566	28,340	−13.3	1.00	1.22
E. I. duPont*	1,920,000*	1,941,385	− 1.1	254,800	292,400	−12.7	8.00	9.26
Food Machinery & Chemical*	300,000	265,000	+13.2	15,790	14,882	+ 6.0	4.70	4.53
Freeport Sulphur	n.a.	n.a.	.....	13,378	12,401	+ 7.9	5.35	4.96
W. R. Grace*	440,000	427,000	+ 3.0	19,950	18,780	+ 6.2	4.45	4.16
Hercules Powder	235,903	226,651	+ 4.1	17,703	19,012	− 6.9	2.13	2.30
Hooker Electrochemical	109,980	104,275	+ 5.5	11,497	11,377	+ 1.1	1.75	1.72
Koppers	307,679	230,261	+33.6	12,096	10,415	+16.1	5.01	4.92
Monsanto	541,883	522,349	+ 3.7	69,410	79,068	−12.2	1.80	1.98
Norwich Pharmacal	29,507	24,827	+18.9	3,374	2,772	+21.7	3.59	3.01
Olin Mathieson*	605,000	560,480	+ 8.0	n.a.	44,558	.....	3.51	3.51
Phillips Petroleum	n.a.	580,252	.....	95,200	95,203	− 0.1	2.78	2.78
Rayonier	137,900	142,521	− 3.2	13,975	15,918	−12.2	2.65	2.87
St. Regis Paper	330,000	257,057	+28.4	22,500	19,048	+18.1	3.15	2.97
Smith, Kline & French	104,631	91,673	+14.1	18,790	15,999	+17.4	3.88	3.30
Spencer Chemical	46,836	39,443	+18.7	5,847	5,157	+13.4	4.67	4.04
Stauffer Chemical	159,215	147,872	+ 7.7	13,745	13,435	+ 2.3	3.97	3.91
Sun Oil	n.a.	n.a.	.....	56,160	48,307	+16.3	5.22	4.72
Union Carbide & Carbon	1,324,507[1]	1,187,153	+11.6	146,233[1]	140,756	+ 3.9	4.86	4.83
West Virginia Pulp & Paper	187,621	176,237	+ 6.5	16,331	15,724	+ 3.9	3.17	3.08

* '56 estimated; † 6 mo. ending Nov. 30; (n.a.) not available; [1] includes Visking Corp., acquired 1956.

Sales Run Faster But Profits Can't Keep Up

Competitive pricing, higher operating costs and heavy depreciation and startup charges keep chemical processors from pocketing much of their sales gains.

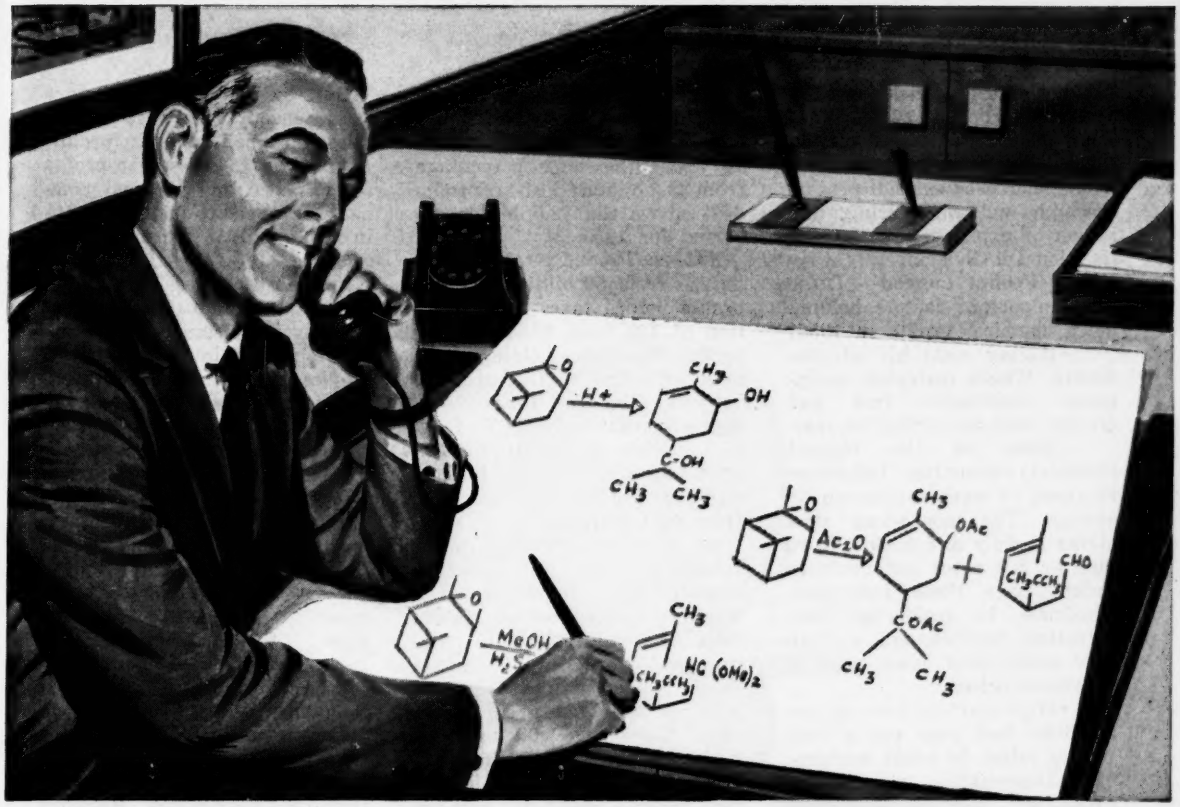
William H. Chartener, McGraw-Hill Dept. of Economics

Most chemical process companies are reporting record sales for 1956, but few of them are throwing their hats in the air over the results. For profits—pinched by higher costs—failed to keep pace with rising sales.

In the chemicals and allied products industry, profits after taxes went up only 2½% while sales climbed 7½%. Note, though, that this inching up of profits in 1956 came after a 39% spurt in 1955, so just holding last year's gains still means very high earnings.

▶ **Big Firms Slip**—Unlike a year ago, some of the financial statements now being issued report dips in profits. The companies whose earnings dropped in 1956 include several major producers—notably Allied, Du Pont and Monsanto. Dow, which uses a May 31 fiscal year, is also running behind year-ago profit levels. Olin Mathieson and Union Carbide earnings show little change.

A variety of factors contributed to tightening profit margins per sales dollar last year. Monsanto, for instance, met intensified competition in the home



Heard the latest about Terpenes?

Becco has epoxidized them! More than five years of research on epoxidation have produced some interesting new products. Dipentene Monoxide and *a*-Pinene Oxide are now out of the laboratory and available, even in drum quantities.

Becco Dipentene Monoxide combines the reactivity of an epoxy group with that of an olefinic double bond in a cyclic terpene molecule. This compound undergoes the usual reactions of the epoxy group and the external double bond in a terpene molecule.

Becco *a*-Pinene Oxide combines the reactivity of an epoxy group with that of the bicyclic system of *a*-Pinene causing it to undergo some unusual reactions. It does not undergo the ring-opening reaction of an epoxide but rearranges in the presence of acid. In water solution, sobrerol is the main product; in anhydrous media, it is campholenic aldehyde.

These terpene oxides have many potential uses as intermediates in the manufacture of perfumes, flavors, pharmaceuticals, protective coatings, insecticides, bactericides, lubricant additives, adhesives, plasticizers, flotation agents, and in organic synthesis.

Typical properties of these epoxides are:

	% Oxirane Oxygen	F.P. °C	B.P. °C	Density at 20°C	Solubility
Dipentene Monoxide	8.9	<—60	74-76 (10 mm)	0.929	Insoluble in water. Soluble in most of the common solvents.
a-Pinene Oxide	9.4	<—60	61-62 (10 mm)	0.963	

Write Becco for experimental quantities and technical assistance in possible application for these compounds. Ask for Becco Bulletins Nos. 81 and 82.

BECCO CHEMICAL DIVISION
Food Machinery and Chemical Corporation
Station B, Buffalo 7, New York

Buffalo • Boston • Charlotte, N. C. • Chicago
New York • Philadelphia • Vancouver, Wash.

CHEMICAL PROGRESS WEEK-APRIL 8-12

Progress in Peroxygens **BECCO**

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

FMC CHEMICALS INCLUDE: **BECCO** Peroxygen Chemicals • **WESTVACO** Phosphates, Barium and Magnesium Chemicals • **WESTVACO** Alkalis, Chlorinated Chemicals and Carbon Bisulfide • **NIAGARA** Insecticides, Fungicides and Industrial Sulphur • **OHIO-APEX** Plasticizers and Chemicals • **FAIRFIELD** Pesticide Compounds and Organic Chemicals

laundry detergent field as sales of "all" dropped 10%. Monsanto also listed as drags on earnings: lower sales of ammonia, increased expenditures on research and engineering, and higher oil exploration outlays by its Lion Oil division.

▶**Why Profits Lagged** — These were important factors holding down chemical profits in 1956:

• Higher costs hit all producers. Wages, materials, equipment, containers, fuel and freight went up during the year.

• Some of the biggest chemical-consuming industries slumped, or were shut down by strikes. The month-long steel strike in July and a slow third quarter for autos put dents in orders from these industries. Weakness in residential construction, textiles and agriculture either held down sales or depressed prices.

• High start-up costs on new facilities last year put a temporary crimp in profit margins.

• Depreciation charges on expanding chemical production facilities rose 8% in 1956, even though defense amortization benefits began to slide off. (These higher depreciation charges, while they pull down reported earnings like any other cost, mean greater cash flow.)

• Increased capacity and sharper competition in such important areas as ammonia, plastics and synthetic fibers kept chemical manufacturers from boosting prices enough to cover their own cost increases, or even holding steady.

▶**Sales Vs. Profits**—Process industries should show financial totals something like this when final figures are reported by the Federal Trade Commission and Securities and Exchange Commission:

Chemicals and Allied Products—Net sales up 7½% over the 1955 record of $20 billion; profits before taxes up slightly under 2% from $3.2 billion; profits after taxes up a little over 2% from $1.7 billion in 1955.

Paper and Allied Products—Net Sales 6% over the $9.8 billion total for 1955; profits before taxes up about 2½% from $1.2 billion; post-tax profits up about the same percentage from $604 million.

Petroleum Refining—Net sales 7½% higher than the 1955 figure of $22.8 billion; pre-tax profits up about the same percentage from $3.2 billion; post-tax profits 6½% above the $2.5 billion reported for 1955.

Rubber Products—Net sales up 2% from $6 billion in 1955; profits before taxes off a fraction of 1% from $554 million; profits after taxes holding about even with $268 million in 1955.

Stone, Clay and Glass Products—Net sales up 7½% from $7.4 billion in 1955; pre-tax profits up 10% from $1.2 billion; post-tax profits also up 10% from $631 million.

All process industries except rubber products ran ahead of manufacturing industries as a whole in the percentage rise in sales. But only petroleum refining and the ceramic group (stone, clay and glass) showed a better improvement in profits after taxes. For all manufacturing corporations the 1956 increase in sales was 5%; in pre-tax profits, 1½%; in post-tax profits, 2½%.

▶**Some Did Better**—Some individual companies managed to buck the tide of narrower profit margins in 1956 and showed greater percentage gains in profits than in sales. Air Reduction, American Marietta, Atlas Powder and Diamond Alkali, for instance, all showed percentage profit increases roughly twice as great as percentage sales increases.

Chemical Trouble Spots?*

Inventories are up

(million dollars)

	1955	1956
Chemicals	$3,042	$3,505
Paper	1,149	1,411
Petroleum refining	2,793	3,207
Rubber	1,106	1,235
Ceramic	890	1,087

Cash holdings are down

(million dollars)

	1955	1956
Chemicals	$2,810	$2,604
Paper	1,266	1,181
Petroleum refining	3,124	3,231
Rubber	516	381
Ceramic	1,158	1,043

*End of third quarter

But, by and large, the story was: encouraging growth in sales, disappointment in profits. As a ratio to sales, net profits after taxes for chemical companies dropped to just under 8% in 1956; in 1955 the profit margin was 8.3%.

▶**Two Troubles** — Throughout the process industries, except possibly petroleum refining, balance sheets point up two items that could cause trouble. Inventories have been rising, and holdings of cash and government securities have been declining.

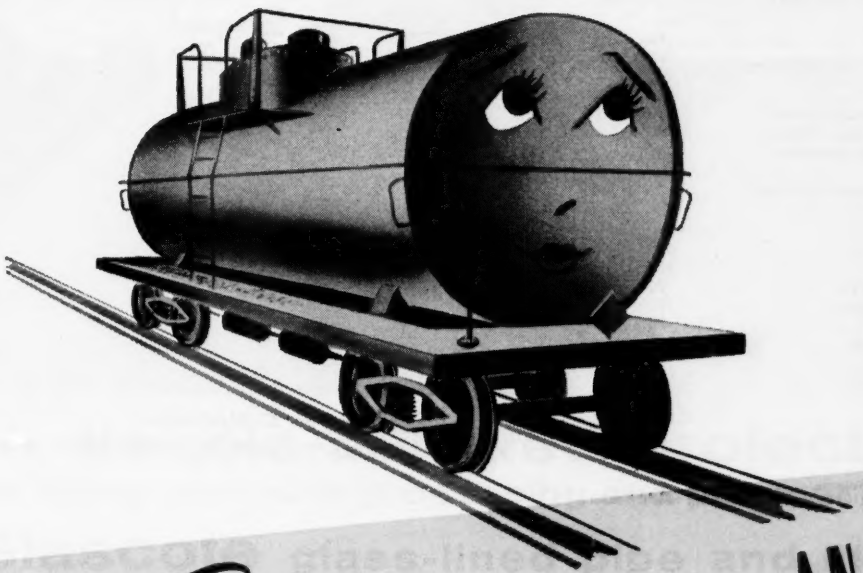
Chemical companies reported a 16% rise in inventories between the end of the third quarter of 1955 and the same time in 1956. Paper companies had a 23% rise in inventories in the same period; stone, clay and glass, 22%; petroleum refining, 15%; and rubber, 12%.

▶**Less Liquidity** — Chemical companies held 8% less in cash and government securities at the end of the third quarter of 1956 (the latest figure available) than they did a year before. Holdings dropped 7% in paper; 10% in stone, clay and glass; and 27% in rubber. Petroleum refining companies increased their holdings by 4%.

These smaller holdings of cash and liquid government securities reflect the "tight money" situation. With higher interest rates, it becomes expensive to hold either your own money or borrowed funds.

The decline in cash holdings reflects also the big pickup in spending on new plants and equipment by the process industries. In these industries, where heavy reliance on internal funds for expansion is traditional, a further drop in available cash might squeeze capital expenditure budgets.

▶**1957 Will Be Better** — Some improvement in profit showings is expected in 1957. Even the spotty slumps in chemical-consuming industries during 1956 did not slow down the growth rate in sales appreciably. And most of these industries should do better this year. Steel is assured of labor peace, and even a modest improvement in auto production will aid industries that are big customers for chemicals.



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XUM

United States Sulfur Output: Bustling . . . but with a couple of slow spots

(Thousand long tons, sulfur equiv.)

Sources	1954		1955		1956*	
Sulfur mined (Frasch)	5,516		5,743		6,425	
Producers' year-end stocks	3,228		3,181		3,901	
Change in producers' stocks	+206		−47		+720	
Apparent Frasch sulfur sales		5,310		5,790		5,705
Sulfur from H_2S	357		402		485	
Producers' year-end stocks	109		111		111	
Change in producers' stocks	+2		+2		...	
Apparent H_2S sulfur sales		355		400		485
Imports	...		25		225	
Low-grade ore	35		45		30	
Domestic pyrites	395		350		360	
Imported pyrites	125		170		175	
Smelter gases	275		345		355	
Sour gases and sludge to acid	230		270		350	
Withdrawn from users' stocks	+79		...		+100	
Total sulfur in alternates		1,139		1,205		1,615
Total equivalent sulfur supply		6,804		7,395		7,805
Uses						
Wood pulping [1]	400		425		450	
Carbon bisulfide	215		300		275	
Other chemicals, dyes	90		125		130	
Insecticides, fungicides	100		125		130	
Rubber	75		80		80	
Other non-acid uses	135		195		175	
Sulfuric acid						
As sulfur	3,025		3,322		3,330	
As alternates	1,129		1,195		1,605	
Exports	1,635		1,598		1,600	
Users' stocks	...		30		30	
Total sulfur used		6,804		7,395		7,805

Inventories — hit six-year high

Imports — soar ten-fold

Exports — barely hold their own

*Chemical Engineering estimate.
[1] Includes pyrites sulfur (10,000 long tons est.) going to sulfite liquor.

Upstarts Snap at Heels of Sulfur Kings

Something new has been added. For the first time since the turn of the century the busy U. S. sulfur industry faces some real world-wide competition.

T. Peter Forbath, Assistant Editor

With world sulfur hunger mounting at a startling rate—Ike's Material Policy Commission predicts consumption will double itself by 1975—U. S. producers not unexpectedly made 1956 their third consecutive record-shattering production year.

They pumped 6.5 million long tons of sulfur from Frasch domes, topping 1955 by 12%; recovered 485,000 long tons from sour gas for a 20% boost; stepped up pyrites and smelter gas contributions to the sulfur pool by about 3% each. And from the looks of things so far this year they're well on the way to crowning these figures.

▶**The Other Side**—Yet, handsome as they are, these production figures tell only part of the 1956 sulfur tale. For the rest, industry observers point to other numbers in the U. S. sulfur balance sheet (see table).

Despite a 12% production hike, Frasch sulfur sales dropped nearly 2% to 5.7 million long tons while producers' stocks soared to 3.9 million long tons—highest level they've reached since the Korean War. Exports in 1956 just managed to hold at the 1955 level of 1.6 million long tons. Imports soared in one year from virtually nothing to a solid 225,000 long tons.

Viewed against the backdrop of the booming world sulfur market these figures spell out a condition brand-new to the annual sulfur story: U. S. producers are beginning to feel the impact of foreign competition.

▶**Mexican Challenge**—Far and away the chief threat is being mounted by that much-heralded brimstone empire of Mexico's Vera Cruz Jungle.

Producing some 800,000 long tons of sulfur, the Mexicans shipped 550,000 last year to visibly slice into traditionally-American domestic and foreign marketplaces. U. S. producers slashed their export price from $31 to $28/ton last summer to bid in foreign ports against 325,000 tons of $26/ton jungle brimstone. By year's end even U. S. sulfur users had bought 225,000 tons of the Mexican mineral.

Best guesstimates place Mexi-

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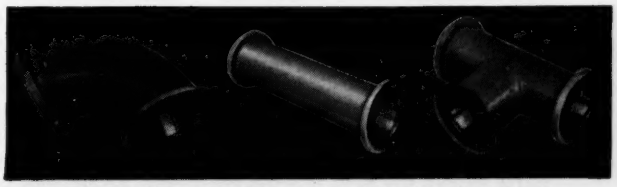

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U. S. Sulfuric Acid Use Was Up Despite the Steel Strike

(Thousand short tons, 100% acid)

Sources	1954	1955	1956*
Sulfur	10,310	11,300	11,848
Pyrites	1,330	1,702	1,780
Smelter gases	886	1,112	1,145
Sour gases	265	170	180
Refinery sludge [1]	480	700	735
Total new acid	13,271	14,984	15,688
Spent acid refortified [2]	725	774	672
Acid reused as such	1,104	1,250	1,150
Total recycled acid	1,829	2,024	1,822
Total acid available	**15,100**	**17,008**	**17,510**
Uses (gross before recovery)			
Fertilizer materials			
Superphosphate and mixing	4,060	4,650	4,650
Ammonium sulfate	1,320	1,650	1,600
Chemicals	3,880	4,195	4,350
Petroleum refining	1,770	1,800	1,900
Inorganic pigments	1,300	1,400	1,450
Rayon and film	620	750	850
Iron and steel	850	1,160	1,265
Other metallurgical	220	248	265
Industrial explosives	400	450	475
Textile finishing	30	30	30
Miscellaneous [3]	650	675	675
Total acid used	**15,100**	**17,008**	**17,510**

*Chemical Engineering estimate.
[1] Sludge burned in sludge-conversion plants is reported as new acid replacing approximately an equivalent amount of new sulfur.
[2] Spent acid used as drip acid in contact plants. Reported in "gross acid" by Bureau of Census.
[3] Includes estimated gross acid to military explosives.

can production in 1957 at over one million tons, with about 400,000 crossing the Rio Grande, some 500,000 headed for foreign ports.

▶ **Northern Bid, Too**—Canada, long a key pyrites nation with mushrooming exports, moved rapidly ahead last year in raising a strong sulfur-from-sour-gas industry. Once able at best to supply less than 30% of her own elemental sulfur needs, she now produces up to 60%, and by 1959 may be in the exporting business with recovered sulfur as well as pyrites.

Too, Japan, Spain and Italy have been expanding their fool's gold production, plan exports within the next few years. And now comes word, for what it's worth, from behind the Iron Curtain, that rich deposits of brimstone have been located in Poland.

But American producers have little patience with the gloom merchants who've been predicting their demise in light of this new competition. With the world's busy industrial activity well able to absorb more than the increased sulfur production, the U. S. sulfur industry—like the strong champion that it is—remains calm and optimistic.

▶ **Mexican Action**—Still colored with the rugged romance of a new frontier, the Isthmus of Tehuantepec continues to lure pioneering-minded sulfur men.

Texas Gulf Sulphur, with over $8 million invested in Mexico, floated a prefab Frasch plant down the Coachapa river last summer to its promising Nopalpa dome (see photo, p. 212). Plant's expected to swing on stream by mid-year, bring 60,000 long tons of brimstone to the surface by year's end.

Freeport Sulphur early this year took over the Mexican sulfur properties of Sulphur Exploration Co. of Houston—a 36,700-acre concession on the Isthmus of Tehuantepec.

Pan American Sulphur, king of the Mexican outfits, doubled its operations last year with a $1.5 million investment, produced 750,000 long tons of sulfur from its Jaltipan dome during the year. At its present rate, PAS seems headed for a one-million-ton 1957.

Gulf Sulphur's Salinas dome accounted only for most of the remaining 50,000 tons of sulfur taken from the jungle floor last year. For Mexican Gulf Sulphur fell upon hard times during the year, was forced to shut down its rich San Cristobal dome. Plagued with legal wrangles and technical difficulties, Mexican Gulf's not yet been able to resume production.

Texas International Sulphur announced this year that it's begun construction on a Frasch plant at the Texistepec site. To cost $3.5 million, the plant is expected to be on stream by 1958, produce 1,000 tons/day.

▶ **Stirring the Waters**—American producers stepped up their sulfur activity in off-shore waters in face of Mexico's new strength.

Late last year Freeport Sulphur took over Humble Oil's government lease to Grand Isle Block 18—located six miles out from the coast of Louisiana under 45 ft. of Gulf waters. Construction of Frasch facilities is scheduled for 1958, with production by late 1960. Along with the lease, Freeport received rights to Humble's Grand Isle Block 16 and West Delta Block 30.

On the debit side of off-shore prospecting, Freeport gave up its San Luis Pass dome of the Texas coast near Galveston. The hoped-for deposit cost the company $1.5 million, delivered only a lot of good under-water-drilling experience for the money. But Texas Gulf's off-shore hope not far from San Luis Pass continues to show promising prospects.

▶ **Busy Salt Domes**—Frasch sulfur production, in topping 6 million tons for the first time, scored its biggest year in the face of two dome mortalities.

Last of Freeport's Texas domes, Nash, was shut down and Texas Gulf's giant Moss Bluff dome fell victim to the tragic drought afflicting Southwestern U. S. With life-blood water scarce, TGS sliced production at Moss Bluff by 75%, feels reduced production will continue until rains come to raise the Trinity river. But to even matters up, Texas Gulf expects to bring its new Fannett dome in Jefferson County on stream by this summer.

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Crystal

$Pb(NO_3)_2$ — F. W. 331.226

Assay ($Pb(NO_3)_2$)	99.0 %
Insoluble Matter	0.010%
pH of 20% Solution at 25°C.	3.0-4.0
Substances not precipitated by H_2S (as SO_4)	0.30 %

Color—White

LEAD ACETATE,
Technical
Crystal
Small Crystal
Granular 4-20 Mesh
Powder

$Pb(C_2H_3O_2)_2.3H_2O$ — F. W. 379.35

Assay ($Pb(C_2H_3O_2)_2.3H_2O$)	99.0-105.0%
Insoluble Matter	0.020 %
pH of 5% Solution at 25°C.	5.5-6.5
Substances not precipitated by H_2S (as SO_4)	0.20 %

Odor: Faint Acetic Acid
Colorless and free flowing

Crystal—Size:
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Granular 4-20 Mesh:
Max. 15% On U.S. No. 4 Sieve
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Bulk (untapped): 50 Gm 35-42 ml.

Small Crystal—Mesh:
Max. 25% On U.S. No. 4 Sieve
Min. 75% On U. S. No. 40 Sieve
Max. 20% Thru U.S. No. 140 Sieve

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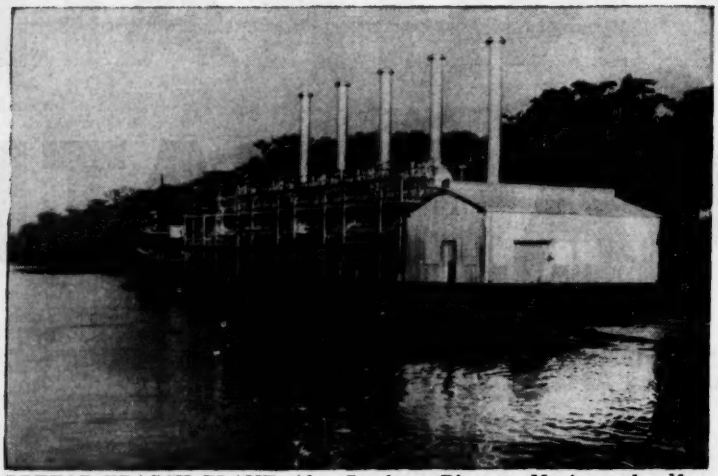


PREFAB FRASCH PLANT rides Coachapa River to Mexico and sulfur.

▶**Non-Frasch Activity**—Sulfur recovery from hydrogen sulfide was spurred last year by the drive on atmospheric pollution at petroleum refineries. U.S. plants—e.g. Hancock Chemical (Wilmington, Calif.), Gulf Oil (Port Arthur, Tex.) and Union Oil (Santa Maria, Calif.)—expanded recovery facilities. At least five new recovery plants—for Tidewater Oil (Delaware City, Del.), Great Northern Oil (Pine Bend, Minn.), Union Oil (Oceano, Calif.), Continental Oil (Billings, Mont.) and Phillips Chemical (Andrews County, Tex.)—came on stream during the year.

But the biggest non-Frasch news comes from Canada. Jefferson Lake Sulphur, teamed with Pacific Petroleum, started building the world's largest (300-600 tons/day) sulfur recovery plant in the Pearl River area of British Columbia. And an International Nickel-Texas Gulf combination begins, this year, investigating a pilot plant for the recovery of sulfur from sulfur dioxide—a coveted process that's evaded success for a long time.

▶**Sulfuric End Use**—True to form, sulfuric acid grabbed 80% of the domestically available sulfur. Some 17.5 million short tons of 100% acid were produced for an increase of 3% over record-breaking 1955.

This increase came in spite of 1956's steel strike which lowered acid usage for steel pickling and coke-oven ammonium sulfate. Both uses picked up markedly, however, with the strike settlement.

Acid sales were aided by the booming synthetic detergent, pigment and rayon industries. Strong gains in the manufacture of phosphatic fertilizers towards year's end did much to keep acid volume up in this generally slow-moving industry.

Small Chemical States Spend Big

With $1.1 billion in construction projects brought into production last year, the chemical industry will spend still more—$2.5 billion — during 1957-58. Projects now in the works will cost $1.8 billion, those still in the planning stage, $700 million, according to the Manufacturing Chemists Assn.

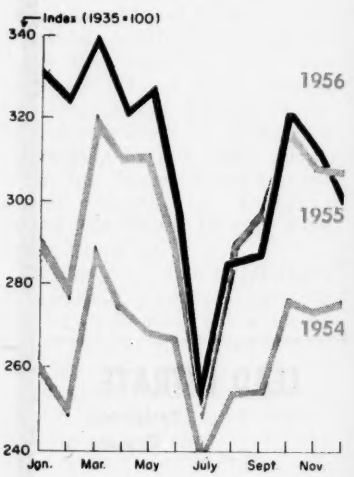
Helping to run up the whopping industry spending figures are companies in some of the least productive chemical manufacturing states.

Florida, which ranks way, way down in production volume, is spending big—more than any other state, save three—to improve its status. Louisiana, 13th among chemical manufacturing states in production, ranks second in spending; West Virginia, 12th in production, rates fifth in spending; and California, tenth in production, comes in third.

Not that some of the big states aren't holding their own. Texas, which ranks third in chemical output, heads the spending list. Ohio, fifth among producers, takes sixth place in spending; Tennessee, eighth in production, has seventh spending spot; and Michigan, seventh in output, places eighth in spending.

Resting on their laurels are New Jersey, chemical production king, but only the ninth biggest spender; Illinois and Indiana, both among the five biggest producers, are running well behind the first ten spenders.

Chemical Consumption



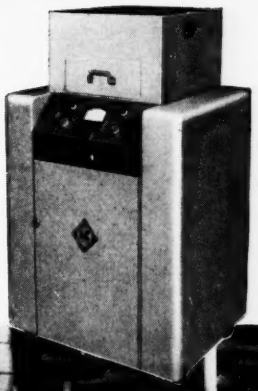
Consumption by Industries

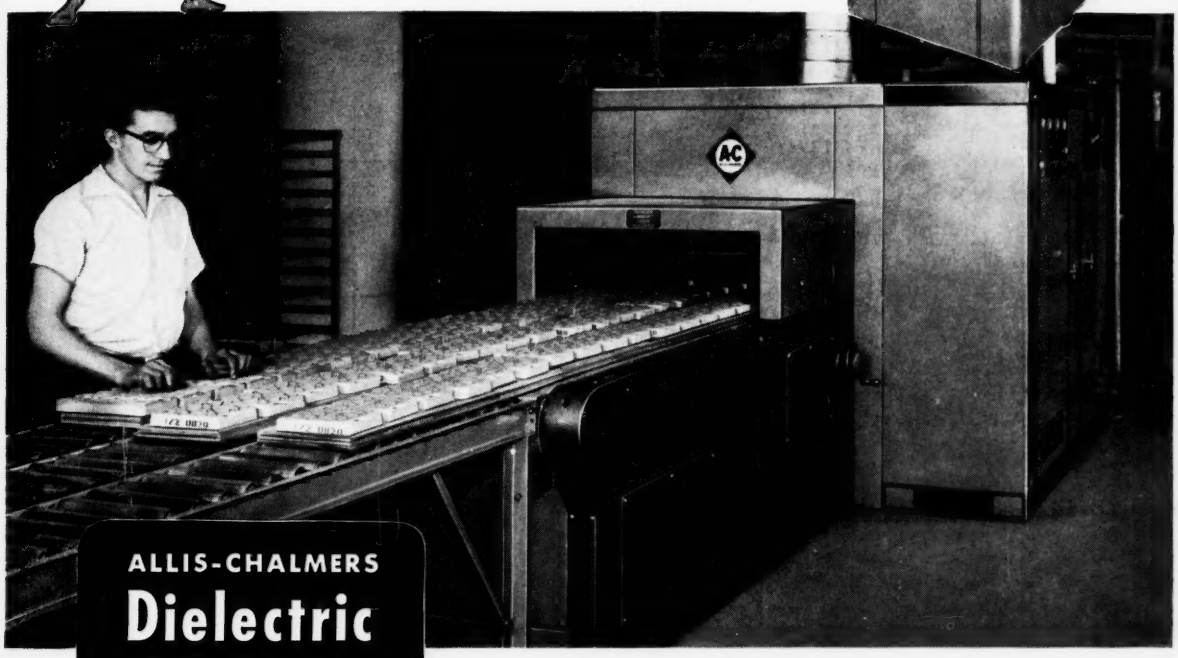
	Nov. (Final)	Dec. (Est.)
Coal products	11.6	12.1
Explosives	11.1	9.7
Fertilizer	69.6	69.3
Glass	26.4	23.5
Iron & steel	19.4	19.9
Leather	4.1	4.0
Paint & varnish	29.2	23.4
Petroleum Refining	31.3	32.7
Plastics	26.0	26.0
Pulp & paper	37.5	34.5
Rayon	27.4	27.7
Rubber	6.4	6.6
Textiles	10.6	9.5
Total	311	299

CHE

XUM

in the laboratory...
on the production line...





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To step this pioneer tranquilizer out of the lab CIBA named liquid extraction for key step (at left), glass-lined and ceramic equipment for critical stages.

Liquid Extraction Commercializes Reserpine

FOR an age aptly described as the one of anxiety, reserpine has opened the way to sorely sought packaged tranquility. But, for a tense society to reap its benefits—which it did last year to the tune of 1.2 million prescriptions worth $25 million—chemical engineers had to map a problem-studded route from lab bench to full-scale production.

CIBA Pharmaceutical Products turned up the process to do the job, received its patent in 1956. On stream since 1954, CIBA's plant at Summit, N. J., now turns out up to 1,000 kg./yr. (about 2,200 lb.) of the tranquilizer and antihypertensive under the trade name Serpasil.

But process pioneering continues. Reports A. C. Shabica, chief of developmental research at Summit, CIBA's present operations represent the third variation on its original process theme. And CIBA engineers right now are putting the finishing touches on a new pilot plant designed to test a fourth.

▶**Process Basis** — Found in small quantities in the exotic roots of the *Rauwolfia* family, resperine is isolated via solvent extraction. In the lab that's a pretty straightforward procedure.

CIBA started with India's magical snakeroot, *Rauwolfia serpentina*, extracting the reserpine with methanol. Then, concentrating the extract by evaporation, it came up with a reserpine-rich tar. Reserpine was leached from the tar with ethylene dichloride, subsequently crystallized from that solvent by concentration.

▶**Engineering Problems** — But in engineering this lab procedure into a commercial plant, as chief of chemical manufacture F. B. Arentz points out, CIBA hit two major roadblocks:

• The large quantities of highly viscous tar turned up in full-scale operation posed a prohibitive handling problem. Thus, instead of evaporating to a tar, CIBA now concentrates the methanol extract to an easily pumped 30% solution and has replaced the ethylene dichloride solid-liquid leach with a more complex liquid extraction stage.

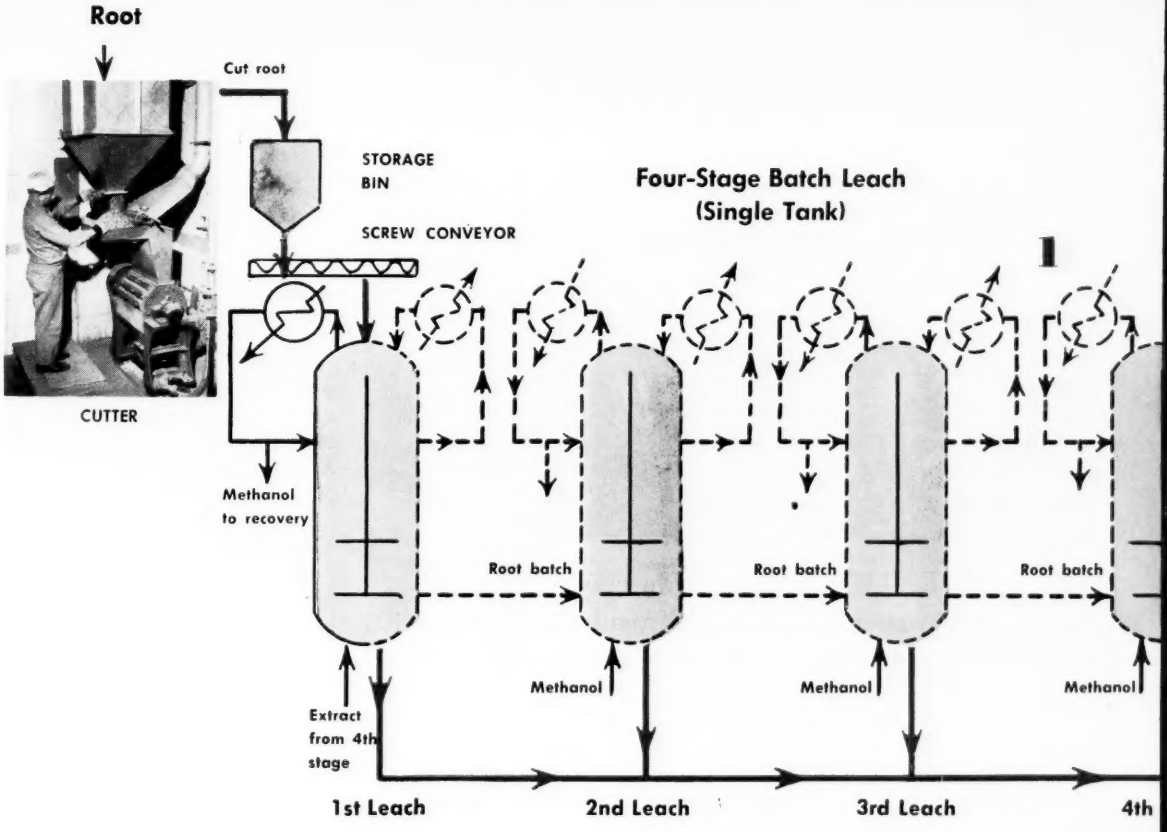
• Chemical disintegration of reserpine, always a delicate matter, is disastrously catalyzed by even the slightest traces of copper. Thus, CIBA turned to stainless steel, glass-lined and ceramic equipment at critical stages.

▶**Batch Leach**—CIBA now uses the African root *Rauwolfia vomitoria* as feed material since the Indian government cut off snakeroot shipments to this country.

Cut to sawdust fineness, the root flies 300 ft. via an air lift to a 350-cu. ft. storage bin. From there it feeds through a 9-in. screw conveyor to two parallel-hooked stainless steel extractors.

CIBA runs the methanol leach as a batch operation. Each batch of roots, supported in the tanks on a cloth-covered screen, is leached four times with boiling (154 F.) methanol. First leach lasts 1½ hr., second 1 hr., third and fourth ½ hr. each. First three solutions from each extractor go to a 1,600-gal. stainless steel holding tank. The fourth is stored separately and used as the initial leach solution for the next fresh batch of roots.

XUM



Before dumping, the roots are steamed free of adhering methanol as a safety measure. Each batch yields from 600 to 800 grams of reserpine, representing nearly 100% recovery.

Methanol extract flows from the holding tank to continuously feed the evaporator, where it is concentrated to a 30% solution.

▶**Liquid Extractions**—Concentrated extract, representing three initial batches, feeds to the key ethylene dichloride extraction stage.

Two stainless steel tanks make up this stage. One serves essentially as a mixing tank and separator, while the other, steam-jacketed, takes on the role of an evaporator as well.

Concentrated extract feeds first to the evaporator, where it is acidified with 15% acetic acid. Then, in the same kettle, petroleum naphtha is introduced to extract fats. Lower layer—the acid solution containing the reserpine—is pumped to the second tank, while the upper naphtha layer is cleared out of the evaporator.

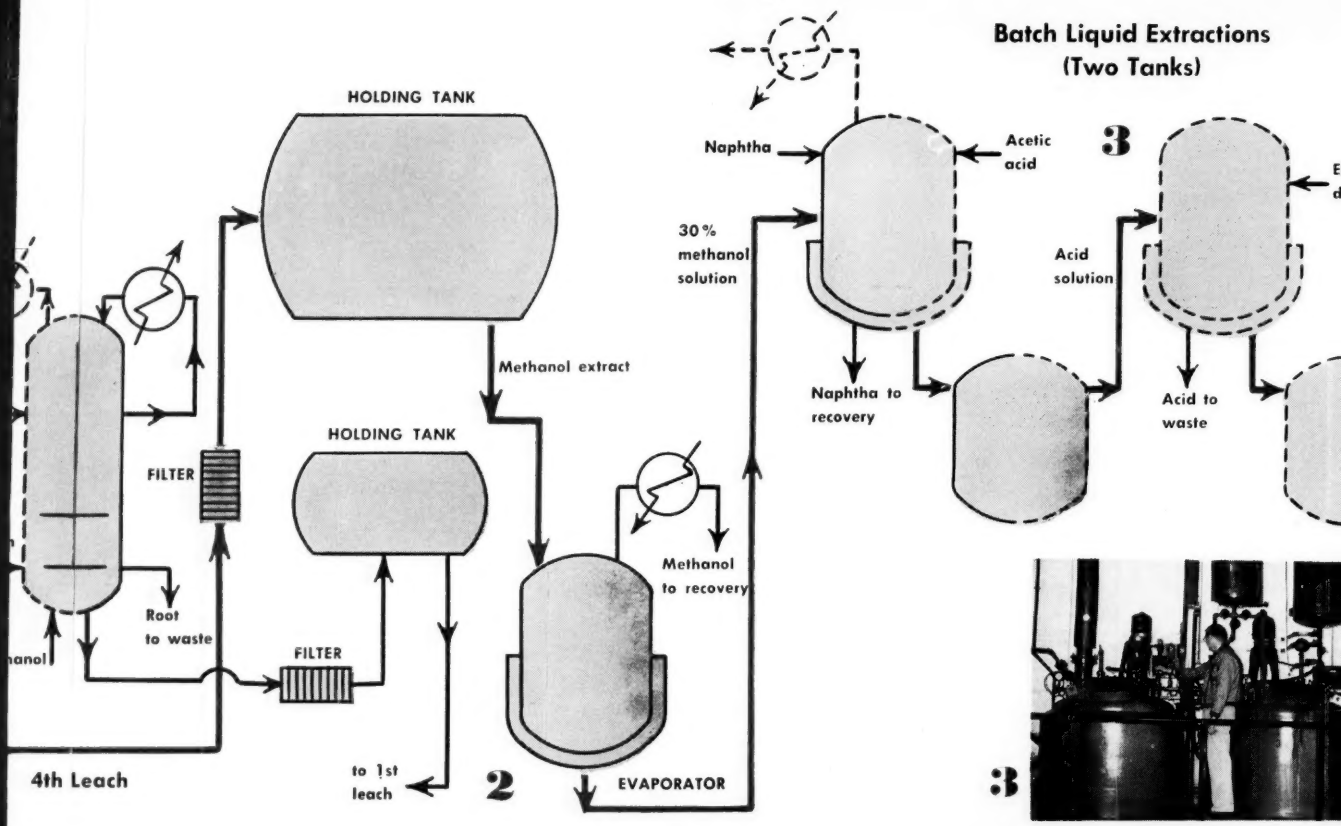
Returned to the evaporator, the acid solution is extracted with ethylene dichloride to recover the reserpine. Leaving behind the acid solution to be dumped, the solvent layer goes back to the second tank to be neutralized with a dilute sodium carbonate solution. Finally, back to the evaporator—which now is used as such—the ethylene dichloride is driven off to leave behind crystals of reserpine.

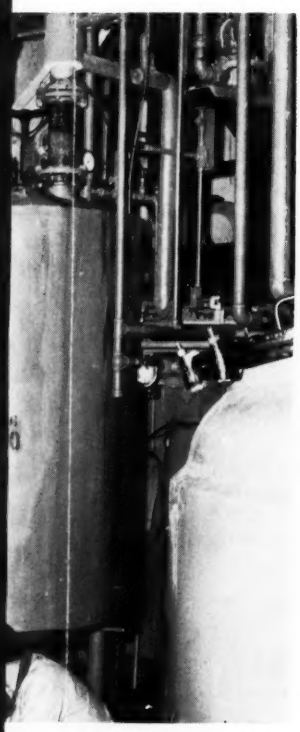
▶**Guard Against Break Down**—Once dried, the reserpine must be protected from chemically disintegrating. So all tanks from this point down the flowsheet line are glass-lined; auxiliary equipment, such as filters, are of ceramic and glass.

Crude crystals are dissolved in methanol, then spontaneously crystallize out without seeding. Dried again, the crystals are dissolved in methylene chloride. This solvent is evaporated away while methanol is introduced simultaneously to wash the pure crystals. After drying, the reserpine crystals are ready for formulation into Serpasil drugs.

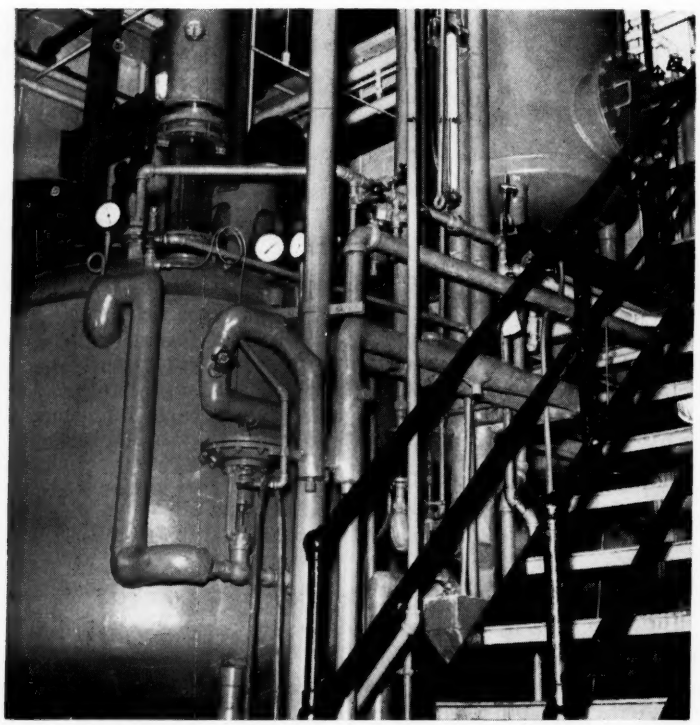
EXTRACTOR: Four stages of boiling batch of cut root (Rauwolfia vomitoria

XUM

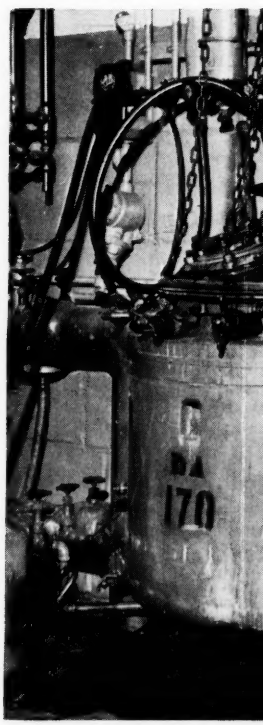




oiling methanol leach each
nitoria) in 500-gal. tanks.

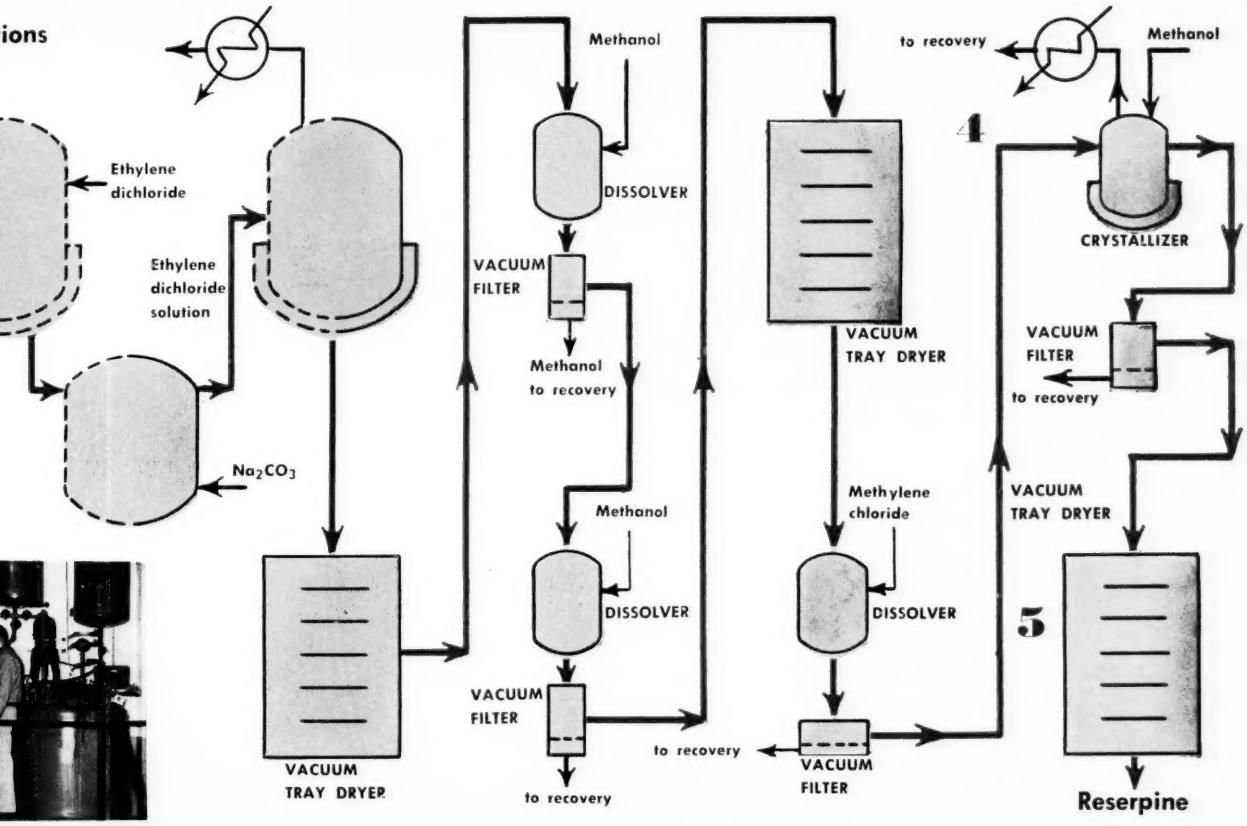


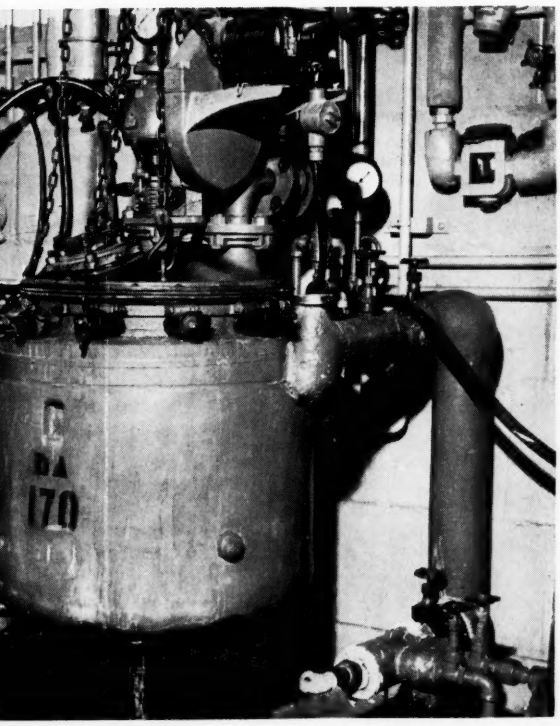
2 EVAPORATOR: Methanol extract is concentrated in 300-gal., steam-jacketed tank to 30% solution; pumped to liquid extractors.



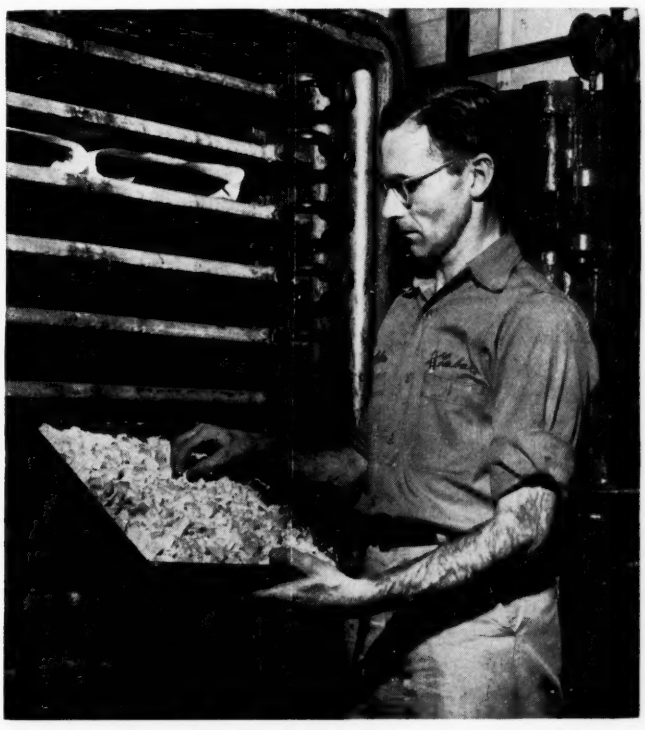
4 CRYSTALLIZER: Dro
tion, reserpine crystals

XUM



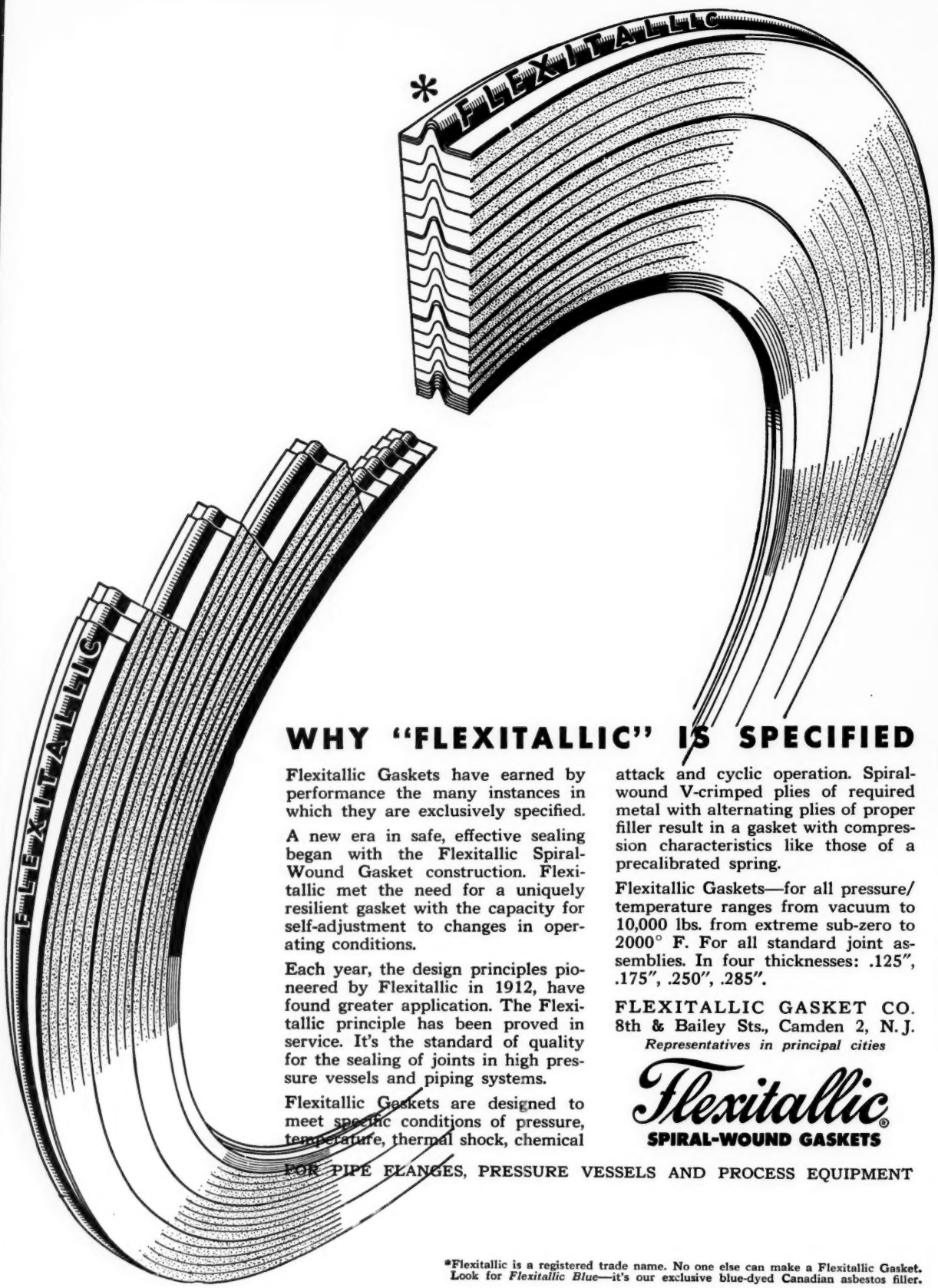


LLIZER: Dropped from methylene chloride by evapora-
rpine crystals are washed simultaneously with methanol



5 VACUUM TRAY DRYER: Reserpine crystals are dried of last traces of methanol and then are prepared for market.

XUM



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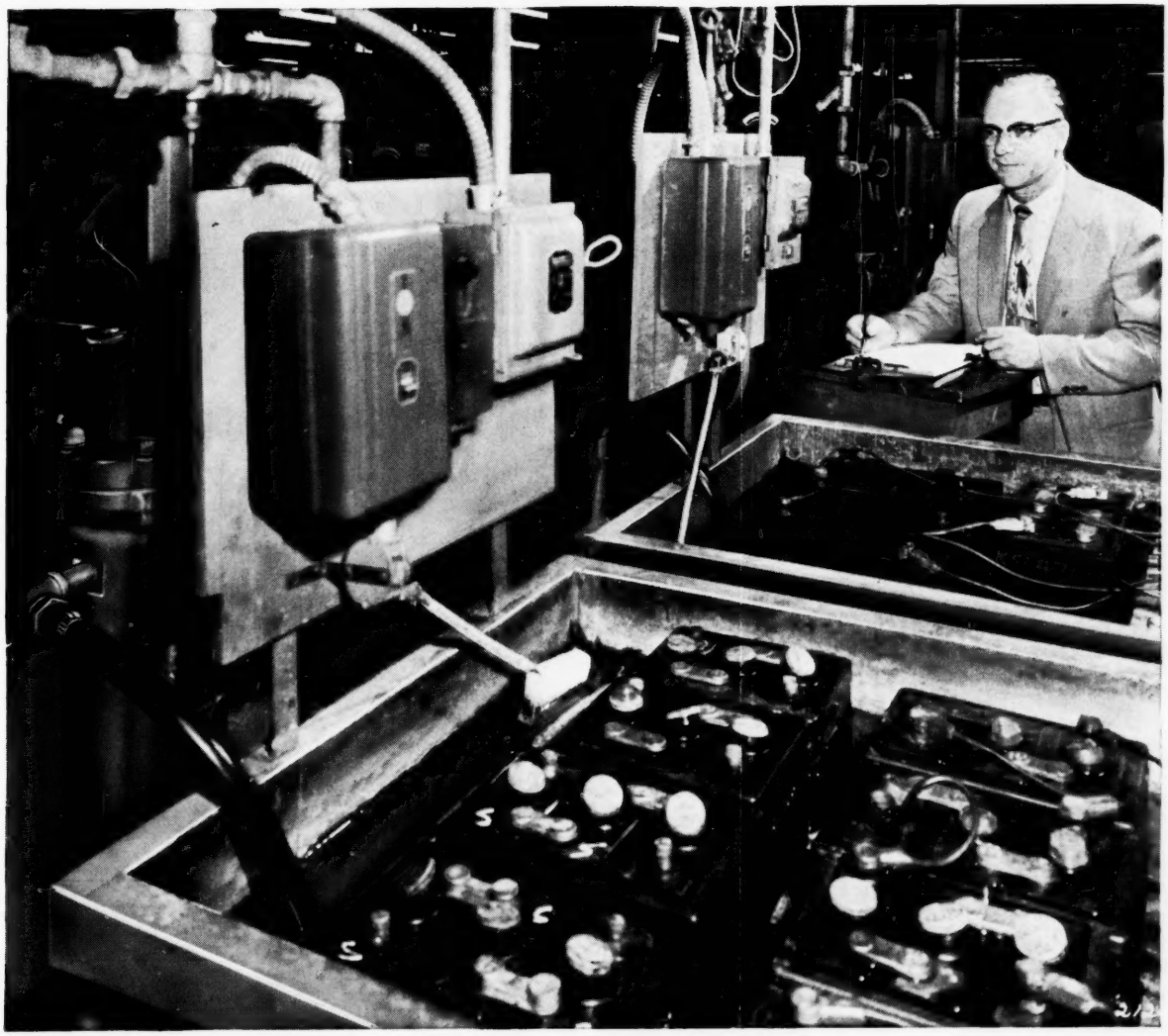

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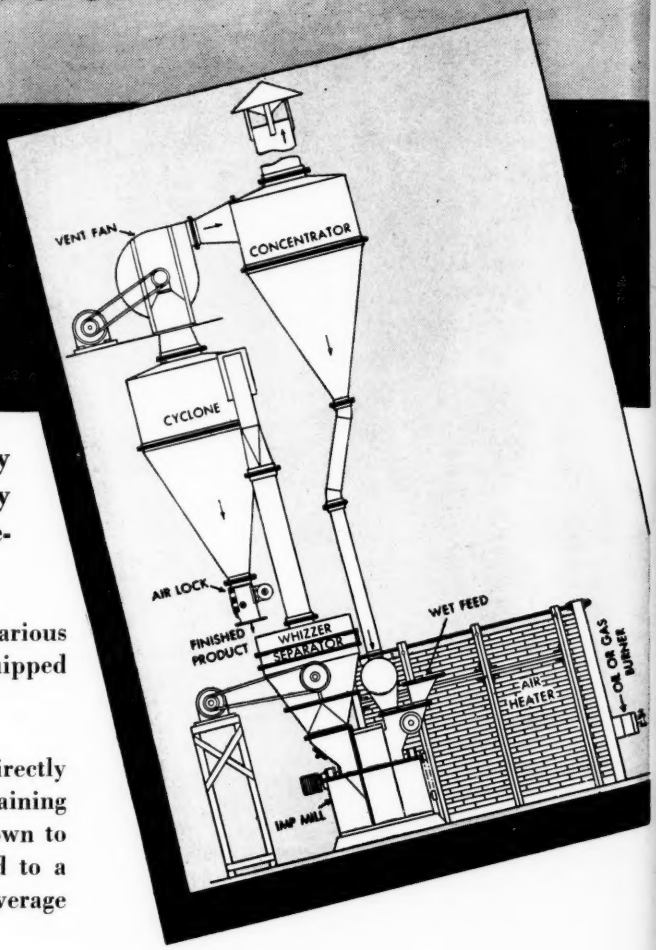

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Tranquilizer gets commercial wings . . . . turn back to p. 230

CIBA's development nerves relaxed when liquid-extraction step lifted reserpine out of the lab, onto the market.

Choose the best centrifugal pump seal 239

Let this 16-page report guide you to the right seal for various pressures, temperatures, operating conditions.

Ejectors simplify design 255

Once upon a time a variety of pressures required a variety of vacuum-producing equipment—till ejector came along.

Use nondestructive equipment checkups 261

For smoother operations in your plant, keep an eye on equipment quality with these nondestructive techniques.

More on gas-liquid contacting 267

This month, our series on flow through packings and beds will tackle gas-liquid contacting in stacked towers.

Add to your design reference file 271

Here's another glimpse into Cushing's own reference file of practical data to help you solve piping problems.

Predict gas conductivity 277

More methods to help you estimate thermal conductivity. This month: predict properties of gases and gas mixtures.

How's your basic design I. Q.? 284

Learn how to get three-component vapor-liquid equilibrium via activity coefficients and boiling-point measurements.

Controller for paper impregnation 290

In less than a year, GE's automatic control system for phenolic resin impregnation of kraft paper paid for itself.

To paint or not to paint 300

You lose when you don't know when you should or should not paint steel equipment. Read the pro's and con's.

APRIL 1957

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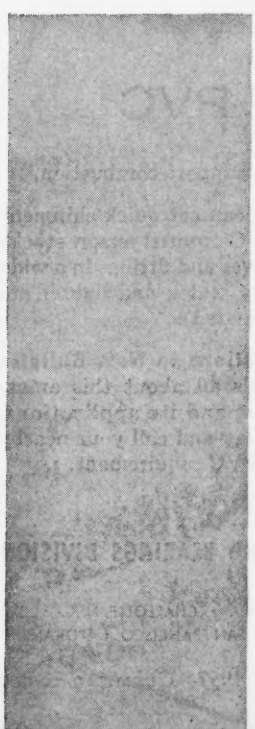

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For pumping chemical solutions at . . .	−65 to +250 F.	
29-in. Hg to 30 psig.	Mechanical	
	Unbalanced with Teflon gaskets	Fig. 6
	Unbalanced outside seal	Fig. 10
	Packing	
	Lubricated packing	Fig. 13
	Cooled packing	Fig. 14
	Canned Pump	Fig. 23
31 to 100 psig.	Mechanical	
	Unbalanced with Teflon gaskets	Fig. 6
	Balanced with Teflon gaskets	Fig. 5
	Unbalanced outside seal	Fig. 10
	Balanced outside seal	Fig. 11
	Packing	
	Lubricated packing	Fig. 13
	Cooled packing	Fig. 14
	Canned pump	Fig. 23
101 to 400 psig.	Balanced with Teflon gaskets	Fig. 5
	Canned pump	Fig. 23

Select Best Pump Seal

For most liquids — including metals and gases. Temperatures: −100 to 800 F. Pressures: −1 to 70 atm.

H. E. TRACY, Byron Jackson Pumps, Inc., Los Angeles, Calif.*

It is safe to say that the designer of the first centrifugal pump could not predict its many and varied future uses. It is also safe to say that this designer could not realize the many troublesome problems that would be the heritage of future centrifugal pump designers.

Early centrifugal pumps were used primarily to handle low pressure water. Their stuffing boxes were simply filled with fibrous material (packing) such as hemp or flax. This prevented excessive leakage where a rotating shaft extended through the wall of the pump.

Developments in petroleum refining, petroleum transportation, high-pressure steam generation, high-temperature, high-pressure chemical production, nuclear power, and many other fields, call for centrifugal pumps able to handle a greater and greater variety of liquids under difficult operating conditions. Pressures and temperatures that were unheard of by early pump designers are now commonplace.

As centrifugal pump design has progressed, a great deal of thought has been given to preventing dangerous and wasteful liquid leakage. Many ingenious methods have

* Meet your author on page 333.

Recommended Methods for Preventing or Eliminating Leakage of Hydrocarbons—Table I

Suction Psig.	−100 to +0F.	0 to 200F.	201 to 400F.	401 to 600F.	601 to 800F.
29 in. Hg to 0	Mech., Fig. 1, 2 Canned pump, Fig. 23	Mech., Fig. 2 Packing, Fig. 13 Canned pump, Fig. 23	Mech., Fig. 1 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 1, 3 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 3, 4 Packing, Fig. 14 Canned pump, Fig. 23
0 to 200	Mech., Fig. 5, 6 Canned pump, Fig. 23	Mech., Fig. 7, 8 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 5, 6 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 7, 9 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 3, 4 Packing, Fig. 14 Canned pump, Fig. 23
201 to 400	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 8 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 5 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 9 Packing, Fig. 14 Canned pump, Fig. 23	Mech., Fig. 4 Packing, Fig. 14 Canned pump, Fig. 23
401 to 600	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 8 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 9 Canned pump, Fig. 23	Canned pump, Fig. 23
601 to 1,000	Canned pump, Fig. 23	Mech., Fig. 8 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23	Canned pump, Fig. 23	Canned pump, Fig. 23

been devised and are available to control or completely prevent this leakage. A knowledge of these methods will allow you to make the best choice of devices.

Degree of leakage to be tolerated depends on the ability of the pump and seal industry to provide a seal or pump to meet the requirements, and first cost and maintenance cost of the unit.

Actually for our purposes, centrifugal pump leakage devices can be divided into the zero leakage types and the controlled leakage techniques. Zero leakage would include the canned pumps. Controlled leakage refers to seals such as packing and mechanical seals.

Usually more than one method is available for a particular situation. Then hazards of leakage to the atmosphere, cost of the liquid, and reliability of the unit must be considered, along with first and maintenance costs, in making a final choice.

Most liquids handled by chemical engineers can be broadly classified into the following groups: hydrocarbons, water, chemical solutions, molten metals, liquid gases.

System pressure on the suction side of the pump however, can vary from 29-in. Hg to 2,500 psig. And temperatures can range from − 320 F. to about 1,600 F. Liquids can be corrosive or non-corrosive, and often carry abrasives.

In this report we will discuss methods in relation to the liquids classified above, at various temperatures and pressures. We will not consider the corrosive properties of these liquids—corrosion is usually a matter of selecting proper materials of construction for the pump or sealing device, and is outside the scope of this report. Therefore, materials of construction will be discussed only as the materials are affected by pressure and temperature.

Sealing Methods

There are a number of methods available for the prevention or elimination of leakage, including packings, mechanical seals, throttle bushings, floating rings, canned pumps, eletromagnetic pumps and frozen seals.

Packings have been used in centrifugal pumps for a long time, and for many applications they are ideal. Packing is enclosed in a stuffing box which holds it against a rotating shaft. A number of packings are available which follow the deformation and motions of a shaft within small limits.

In mechanical seals closure is effected between one rotating and one stationary element. The contact surface is lubricated. But unlike the packing, which seals on the cylindrical surface of the shaft (or sleeve), the mechanical seal surface is perpendicular to the shaft axis. The life of sealing rings is generally longer than soft packings (see *Chem. Eng.*, Sept. 1956).

A throttle bushing is a stationary bushing attached to the pump casing or stuffing box through which the shaft rotates. Clearance between the bore of the bushing and the outside diameter of the shaft is held to a minimum, and the clearance is used to control leakage.

A floating ring assembly is a throttle bushing designed to move radically with the shaft or sleeve in operation. It has close clearances—actually closer than the throttle bushing. Assemblies are made up of a series of short throttle bushings or rings fitted closely to the shaft.

In the seal-less or canned pumping unit, sealing devices are eliminated and leakage is zero. Pump and motor are built together into a single totally enclosed unit. The fluid to be pumped fills the motor cavity, but is isolated from stator windings by a non-magnetic metal sleeve, welded into the stator bore. In the wet-motor type, the sleeve is not used but stator windings are encased or potted with a protective plastic compound. Rotor, shaft and impeller are an integral unit, and rotate together completely submerged in pumped fluid, as are the bearings.

The electromagnetic method of pumping passes a current of electricity through the liquid to be pumped, while the liquid is in the presence of a strong magnetic field. Flow is perpendicular to both the current and the magnetic field.

Other methods, developed primarily to handle liquid metals for nuclear reactor cooling, include the frozen seal (a throttle bushing with the clearance filled with liquid metal), and the gas-filled motor pump.

Pumping Hydrocarbons

Hydrocarbon liquids are commonly handled in petroleum refineries, petrochemical plants, pipelines and the petroleum product marketing industries at suction pressures varying from approximately 29-in. of Hg to 1,000 psig. and at temperatures ranging from − 100 F. and below to + 800 F.

Table I shows preferred methods for non-abrasive hydrocarbons (hydrocarbons carrying only the usual amount of pipe scale found in a well run refinery, pipeline or loading station) over this range of operating pressures and temperatures. For pressures up to 400 psig. through the full temperature range mechanical seals, packing, and canned pumps are used. Above 400 psig. only mechanical seals and canned pumps are shown, as packing maintenance at high pressures is excessive. Canned pumps can be used over the pressure range if they can meet horsepower requirements.

Mechanical Seals

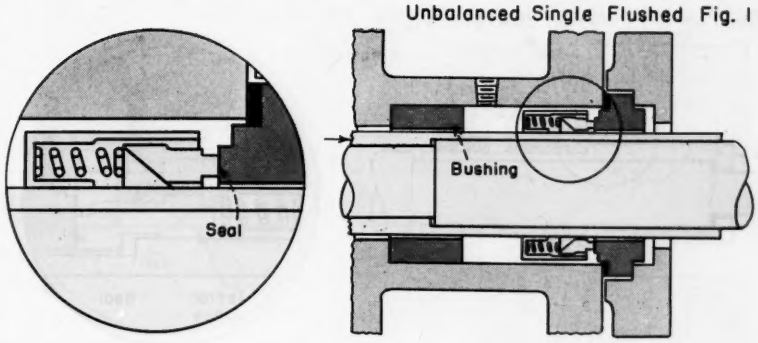
Mechanical seals are available from a number of manufacturers. Essentially, they can be classified into four types: single unbalanced; single balanced; double unbalanced; double balanced.

In a mechanical seal, hydraulic film pressure of the liquid trapped between the seal faces tends to force the faces open. However, this pressure is more than counteracted by the pressure of the liquid in the stuffing box, which acts to force the faces together. At high pressures, a point of unbalance can be reached where no film of lubrication remains on the seal faces. A balanced seal is designed so casing or stuffing box pressure acts on the opposite side of the sealing ring, thus balancing this pressure. A spring then counteracts film pressure. In a double seal, two seals are contained in a single chamber. A clean liquid circulates between the two seals, preventing casing liquid from leaking to the atmosphere.

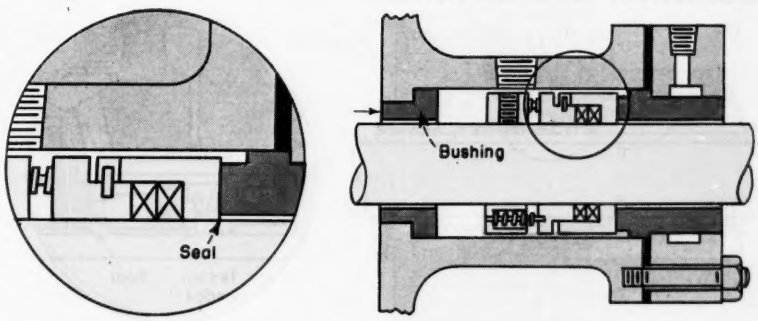
In sealing hydrocarbons the single types predominate. The unbalanced mechanical seal is lower in first cost but has limited pressure applications. Some users limit the unbalanced seal to 50 psig., others to 100 psig. or higher, while

Mechanical Seals

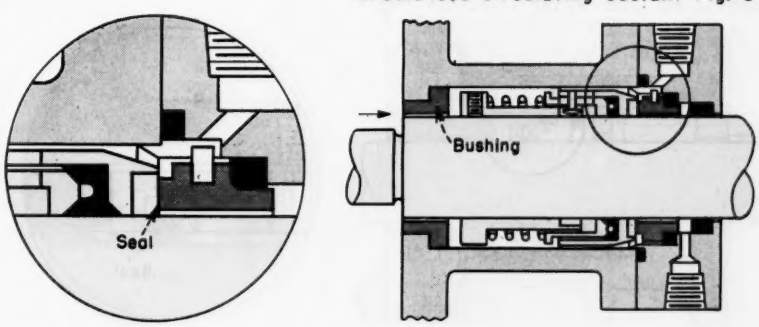
Unbalanced Single Flushed Fig. 1



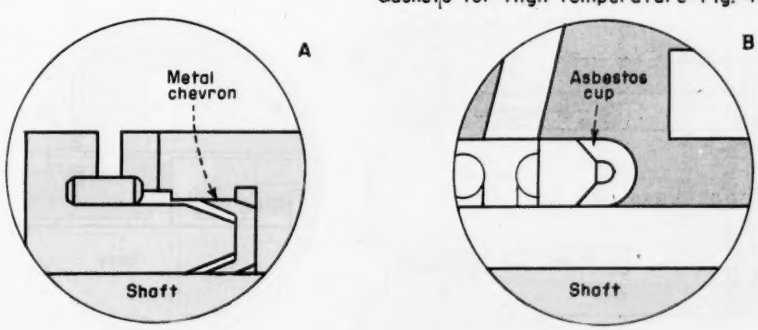
Unbalanced Double Flushed Fig. 2



Unbalanced Circulating Coolant Fig. 3

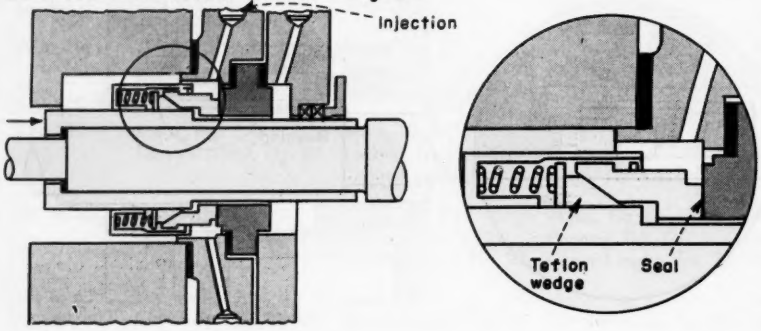


Gaskets for High Temperature Fig. 4

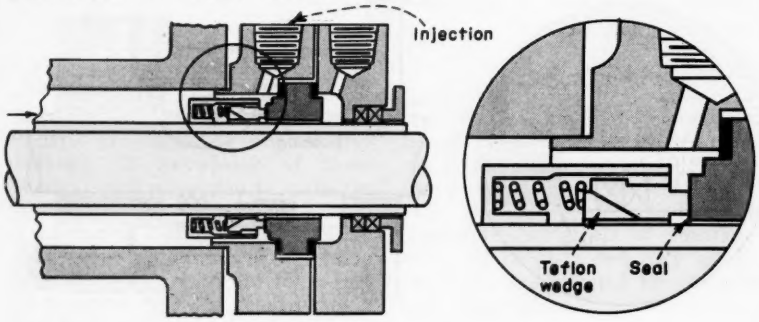


Mechanical Seals

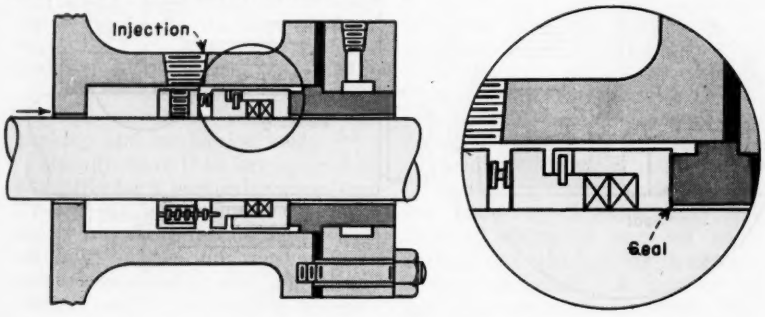
Balanced with Teflon Gaskets Fig. 5



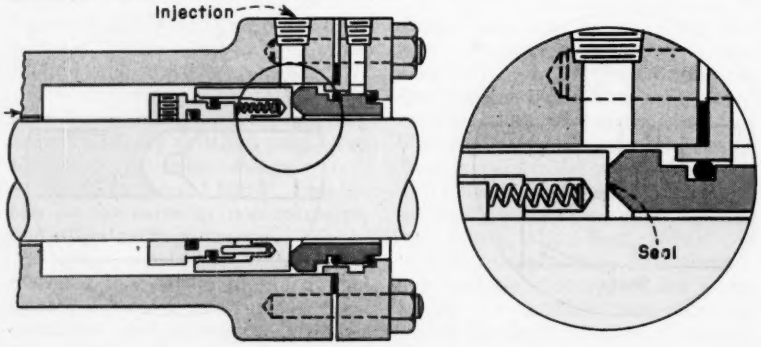
Unbalanced with Teflon Gaskets Fig. 6



Unbalanced Cold Water Injection Fig. 7



Balanced Cold Water Injection Fig. 8



still others let the seal or pump manufacturers determine the limit.

There is an increasing tendency, in handling hydrocarbons, to lower the pressure limits for unbalanced seals. Some refineries, and practically all crude oil and product pipelines, use only balanced seals, regardless of pressure.

Double mechanical seals are seldom supplied for the hydrocarbon field at this time, because development of the single seal has progressed to the point where practically all service in this field can be covered—including pumps handling hydrocarbons and even hydrofluoric acid. Actually, the double mechanical seal heretofore used for hazardous service, like packing, is giving way to the single seal.

It is essential that the proper seal be selected for the service intended and that it be properly installed and piped. Gasket materials are considered only as they are affected by temperature and pressure. Three common gasket materials are in use with mechanical seals: synthetic rubber, Teflon, asbestos.

Synthetic rubber is a low cost material suitable for a practical pump temperature range of -30 F. to $+200$ F. Teflon is a comparatively expensive material suitable for a practical pumping temperature range of from -100 F. to $+400$ F. Asbestos is slightly more expensive than synthetic rubber and has proved excellent for most hydrocarbons in the range of 400 F. to 650 F.

Low Pressures—Figs. 1, 2 and 3 show unbalanced seals for use at pressures from 29-in. Hg to 0 psig.

All examples contain a close-clearance throttle bushing in the bottom of the stuffing box. The stuffing box is piped to a point in the pump where higher than suction pressure exists. Flow from the higher pressure point restricted by the close-clearance throttle bushing builds up pressure in the stuffing box. At least 0 psig. is needed to prevent entrance of air to the seal. Air is detrimental to the seal faces and can accelerate corrosion.

Under pressure conditions 0 to 200 psig., both unbalanced and balanced seals can be used (see Figs. 3 to 9).

Unbalanced seals should be limited to 50 psig. for hydrocarbons having poor lubricating quali-

ties, and to 100 psig. for hydrocarbons having good lubrication qualities. For most products in this pressure range a close-clearance bushing is not needed in the bottom of the stuffing box. But the stuffing box should be piped to a point in the pump where higher pressure exists to create a flow past the mechanical seal for cooling and to prevent abrasives or sludge from collecting around the seal. A throttle orifice can be used in the mechanical seal piping to control flow.

The centrifugal pump requires a net positive suction head, above vapor pressure of the hydrocarbon pumped, to prevent flashing in the impeller eye. This NPSH is measured above the centerline of the impeller and can vary from one or two feet upward. With the stuffing box under suction pressure the NPSH needed for good pump performance may not be sufficient for the mechanical seal. Primarily, heat generated by the seal may flash hydrocarbons into vapor at the seal faces with the result that no liquid is available for lubrication of the faces.

This condition can cause more trouble with light products (sp. gr. approximately 0.6 and below) where the liquids are homogenous or nearly so. With liquids containing two or more fractions with different boiling points, part of the liquid may flash and part may remain in liquid form to act as a lubricant.

High Pressures—For pressures in the range 201 to 400 psig. the balanced seals shown in Figs. 5, 8, 9, and 4 can be used. The NPSH effects apply because the vapor pressures of hydrocarbons such as propane and ethane-methane mixtures are in this pressure range.

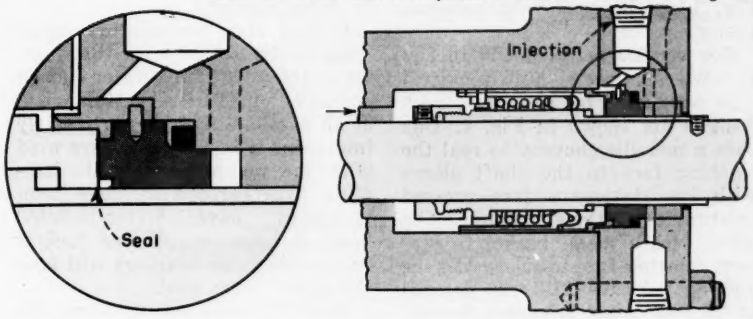
For the range 401 to 600 psig. consider the balanced seals shown in Figs. 5, 8 and 9. NPSH effects apply, but the danger of insufficient NPSH is less, because few homogenous hydrocarbons are pumped with vapor pressures from 401 to 600 psig.

Seals shown in Figs. 5 and 8 are recommended for use under 601 to 1,000 psig. They must be of high quality to withstand the high pressures. Suction pressures in this range are usually found in pipeline service where NPSH is seldom a problem.

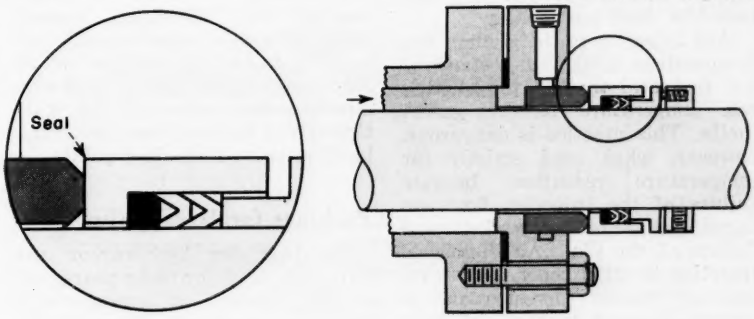
High Temperatures—In the

Mechanical Seals

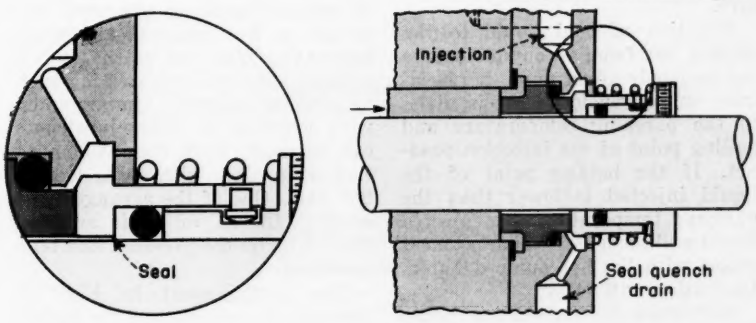
Balanced Cold Water Injection (Metal Gaskets) Fig. 9



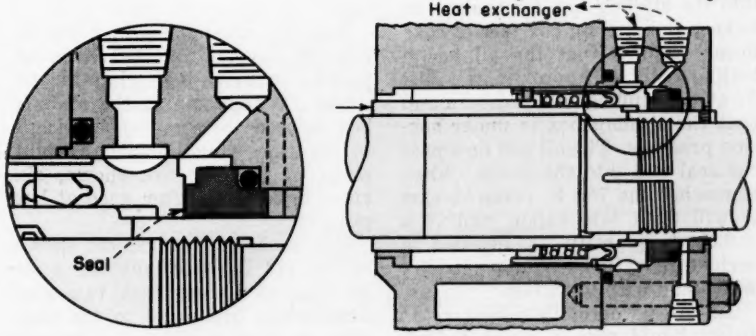
Unbalanced Outside Fig. 10



Balanced Outside Fig. 11



Integral Pump Seal Fig. 12



range from 601 to 650 F. mechanical seals such as the one shown on Fig. 3 can be used with asbestos gaskets.

For service between 650 to 800 F. however, special high temperature seals must be used. Two such designs are shown in Fig. 4. One uses a metallic chevron to seal the rotating face to the shaft sleeve with the stationary face pressed or shrunk into the seal flange. The other uses a metal gasket to prevent rotating-face-to-sleeve leakage and an asbestos "U" cup located in the seal flange to gasket the stationary face. An air space is provided between the shaft and "U" cup for insulation, and a water jacket is used for cooling.

Cold injection to the stuffing box is sometimes used with a standard low cost seal to hold the stuffing box temperature to the gasket limits. This practice is dangerous, however, when used strictly for temperature reduction, because failure of the injection flow can cause failure of the gaskets and failure of the seal. Although cold injection is often beneficial (to reduce or prevent corrosion and to prevent damage to the seal from abrasives) the seal should be capable of withstanding full temperature.

Injection of cold liquid to the stuffing box from an outside source can seriously affect pump performance unless consideration is given to the pumping temperature and boiling point of the injection product. If the boiling point of the liquid injected is lower than the pumping temperature, the injected liquid will flash into vapor when it mixes with the hot pumped liquid. Cavitation will result.

For example, consider a pump handling bottoms from a vacuum still at 750 F. with cold oil injected into the stuffing box for cooling or to keep the stuffing box free of coke fines. Assume that the oil has a boiling point of approximately 450 F. at the stuffing box pressure and that the stuffing box is under suction pressure. The oil will flow past the seal and into the pump. When it reaches the 750 F. pump stream it will flash into vapor, and if a sufficient quantity is injected a serious reduction in pump capacity will occur with vibration.

In cases where it's necessary to inject liquid with a lower boiling point, quantity should be controlled so flow of boiling liquid will not be sufficient to cause much reduction in pump capacity.

In this high temperature range (600 to 800 F.), and for that matter at 400 to 600 F., a water quench should be piped to the seal flange if at all possible. This is particularly important if ball bearings are used with the pump. Most units handling hydrocarbons at these temperatures have water-jacketed bearing housings. Water jackets surrounding the bearings will keep the outer races cool.

Heat transmitted through the shaft can cause expansion of the inner race, which may cause bearing loading, resulting in short bearing life. Therefore, quench water should be used in sufficient quantity to cool the shaft as well as the races. Water quench will also minimize the danger of fire, particularly if hydrocarbons are being handled above their flash point.

Packings for Hydrocarbons

Packings for hydrocarbon use have been used for many years, and a wide variety of arrangements have been developed. (Figs. 13, 14, 15 and 16).

In most cases, die-formed rings of metallic packing are used, although at low pressure and when lubricating qualities of the hydrocarbons are good, soft packing such as woven asbestos impregnated with graphite or other lubricants can be used. Each ring is tamped tightly in place with splits located 90° part. One of the arrangements in Fig. 13, 14, or 16 is selected, depending on the pressure and temperature.

The arrangement in Fig. 15, however, is seldom used for hydrocarbons. It is inexpensive, but does not have a cage ring for oil circulation.

Packing arrangement shown in Fig. 13 consists of eight rings of packing with a cage ring in the center. A pipe tap in the stuffing box is used to introduce lubricant to the cage ring. Although eight rings of packing are shown, six rings or less are often used at low pressures.

The packing arrangement shown in Fig. 14 is essentially the same as Fig. 13 except that two pipe connections are made to the cage ring so that a flow of lubricant can be created through the ring.

The packing arrangement shown in Fig. 16 contains a close clearance bushing at the bottom of the stuffing box with an integral cage ring. A pipe tap connecting this cage ring can be used to inject clear liquid ahead of the packing to prevent abrasive particles or corrosive hydrocarbons from reaching the packing. A cage ring is located in the center of the stuffing box with the in-and-out pipe tap for circulating lubricating liquid. Babbit or lead foil packing is usually used to 400 F., with aluminum foil packing used in the range from 400 to 800 F. for pumping of hydrocarbons.

It's essential that a hard shaft sleeve, such as steel or alloy steel overlaid with Stellite or colmonoy, be used with metallic packing. Sleeves hardened by heat-treatment or other means to get a hardness of at least 400 Brinell are also acceptable.

Low Temperatures — Usually packing is not used in the low temperature range of −100 F. to 0 F. Hydrocarbons handled in this subzero range have poor lubricating qualities. If they escape through the packing they freeze moisture, and ice will build up around the packing gland. Packing can be used with success only to approximately −20 to −30 F. where oil can be used to lubricate the pump packing.

At these low temperatures the packing arrangement of Fig. 13 is generally used. Usually, low viscosity oil is fed to the cage ring at a pressure higher than stuffing box pressure so that a small flow of oil into the pump and to atmosphere is created.

Under the conditions of 0 to 200 F. the packing arrangements shown in Figs. 13 and 14 are suggested. The only difference is Fig. 14 has an inlet and outlet to the cage ring; while Fig. 13 has an inlet only. The Fig. 13 arrangement can be used for most services in this pressure-temperature range, but the Fig. 14 arrangement is preferred in the upper range of pressures and temperatures (160 to 200 F. and 150 to 400 psig.), particularly if the lubricating qualities of the hydrocarbons pumped are poor. In the higher pressure range pressure against the packing produces frictional heat. This heat, combined with heat from the pumped liquid,

can cause packing wear and high maintenance cost.

High Temperatures—For hydrocarbons in the range of pressures and temperatures from 201 to 800 F., and to 400 psig., the packing arrangement of Fig. 14 is generally used.

The high temperatures also require oil circulation through the cage ring as well as a water jacket surrounding the stuffing box. A cowl type gland should be used with cold water quench to smother vapors leaking from the stuffing box and to help prevent heat transfer from the shaft to the bearings. If the ball bearings used with the pump are water jacketed, the bearing outer races are cool. If heat transmitted to the inner race from the shaft isn't removed it can cause expansion of the inner race, resulting in loading the bearing.

Canned Pumps

A variety of canned pumps are available for hydrocarbons. Fig. 23 is a generalized view of a typical canned pump, suitable for water, chemicals, liquid metals and liquid gases as well as hydrocarbons.

One design for temperatures up to 180 F. circulates a portion of the pump liquid internally in the rotor section for cooling and lubrication. This design is limited to clear liquids.

Another design has a tube running from the periphery of the volute to the rear of the pump. A portion of pumped fluid flows through the rotor chamber back into the eye of the impeller. This circulation cools rotor, bearings and stator, and lubricates the bearings.

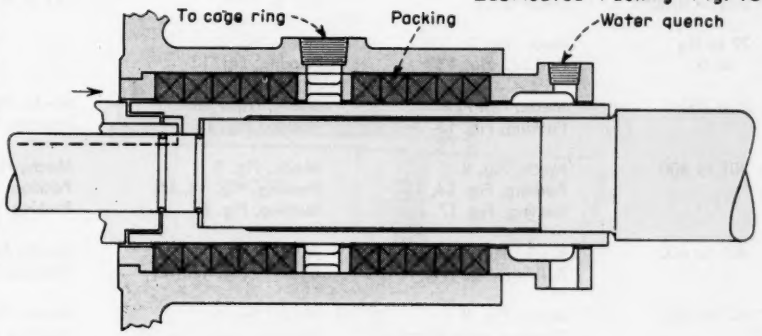
For higher temperatures (up to 1,000 F.) many canned pumps have an integral heat exchanger surrounding the stator. Pump fluid circulates through the exchanger where it is cooled with water, then enters the rotor chamber. This technique keeps the stator winding temperatures within safe limits.

Handling Clear Water

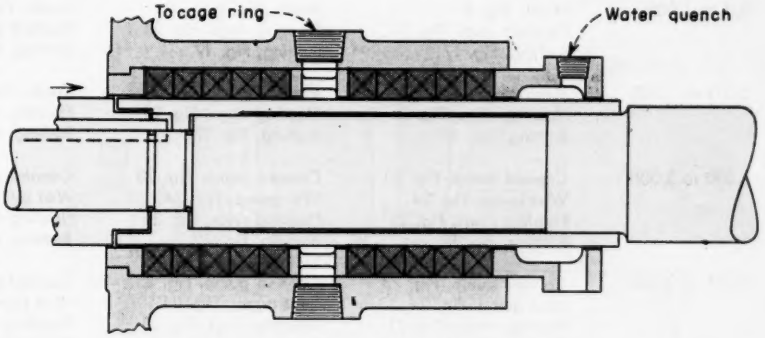
The classification of non-radioactive water is intended to cover water containing not more than the usual amount of abrasives,

Packings

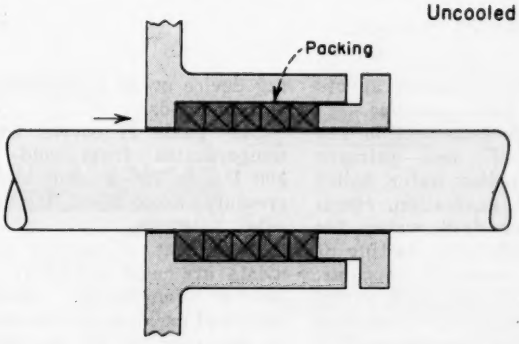
Lubricated Packing Fig. 13



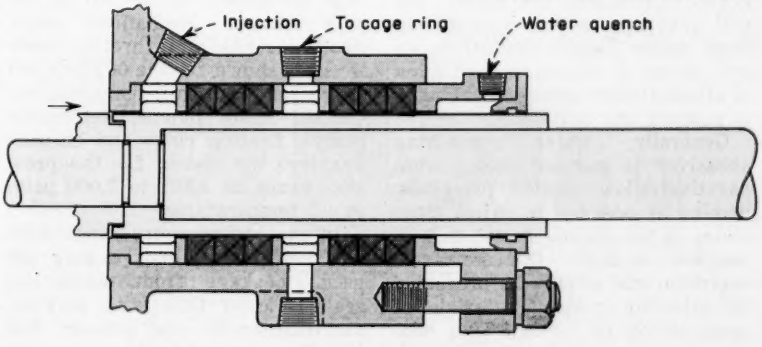
Cooled Packing Fig 14



Uncooled Packing Fig. 15



Prequenched Packing Fig. 16



Recommended Methods for Preventing or Eliminating Leakage of Clear Water—Table II

Suction Psig.	Below 100F.	101 to 180F.	181 to 400F.	401 to 700F.
29 in. Hg to 0	Mech., Fig. 2 Packing, Fig. 13	Mech., Fig. 2 Packing, Fig. 13		
0 to 200	Mech., Fig. 7, 8 Packing, Fig. 15	Mech., Fig. 7, 8 Packing Fig. 15	Mech., Fig. 12 Packing, Fig. 14, 15	
201 to 400	Mech., Fig. 8 Packing, Fig. 14, 15 Bushing, Fig. 17	Mech., Fig. 8 Packing, Fig. 14, 15 Bushing, Fig. 17	Mech., Fig. 12 Packing, Fig. 14 Bushing, Fig. 18, 19	Mech., Fig. 12 Packing, Fig. 14 Bushing, Fig. 19, 20
401 to 600	Mech., Fig. 8 Bushing, Fig. 17	Mech., Fig. 8 Bushing, Fig. 17	Mech., Fig. 12 Bushing, Fig. 18, 19	Mech., Fig. 12 Bushing, Fig. 19, 20
601 to 800	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 18, 19	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 19, 20
801 to 1,000	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 18, 19	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 19, 20
1,001 to 1,500	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 8 Floating rings, Fig. 21 Bushing, Fig. 17	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 18, 19	Mech., Fig. 12 Floating rings, Fig. 22 Bushing, Fig. 19, 20
1,500 to 2,000	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 21 Bushing, Fig. 17	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 21 Bushing, Fig. 17	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 22 Bushing, Fig. 18, 19	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 22 Bushing, Fig. 19, 20
2,001 to 3,000	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 21 Bushing, Fig. 17	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 21 Bushing, Fig. 17	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 22 Bushing, Fig. 18, 19	Canned pump, Fig. 23 Wet pump, Fig. 24 Floating rings, Fig. 22 Bushing, Fig. 18, 19

salts and other corrosive agents found in city water supplies.

Water in this classification has many industrial uses—primary water supply, cooling water, boiler feed for steam generation, circulation of boiler feed water for greater boiler efficiency, testing of high pressure vessel systems, etc.

Water can vary from high purity to extremely corrosive; it can contain abrasives and can be used to carry abrasives such as sand and gravel in dredging operations. We will deal only with comparatively clear water (space limitations do not permit a thorough discussion of all conditions under which water is pumped and sealed).

Generally, water containing abrasives is pumped under comparatively low suction pressures, making it possible to inject clear water to the sealing device to help prevent damage. Damage from corrosion can usually be prevented by selecting proper materials of construction or by injecting noncorrosive clear water to the sealing device or by a combination of both methods.

The Table II covers water at temperatures from cold (below 100 F.) to 700 F. and at suction pressures from 29-in. Hg to 3,000 psig.

A number of sealing arrangements are used depending on the service conditions. Mechanical seals and packing are recommended to 400 psig. at all temperatures. Mechanical seals and throttle bushings are shown for the 401 to 600 psig. range. Mechanical seals, floating rings and throttle bushings are shown for the 601 to 1,500 psig. range at all temperatures. Canned motor pumps, wet motor pumps, floating rings and throttle bushings are shown for the pressure range of 1,501 to 3,000 psig. at all temperatures.

In the low pressure range both mechanical seals and packing are used. Leakage from mechanical seals is lower than with packing, and maintenance cost is lower. But the first cost of a pumping unit with mechanical seals is usually slightly higher, which accounts for continued use of packing.

In all cases, final selection is usually dependent on the amount of leakage to atmosphere that can be tolerated and first cost and maintenance of the unit, although there are often other considerations. For example, in the 2,000 psig. range it may be desirable or necessary to drive the pump with a steam turbine, thus automatically eliminating the canned or wet motor pump. Or leakage to atmosphere may be of no particular concern, permitting use of throttle bushings or floating rings with a conventional pump and motor or turbine. Or zero leakage may be desired with motor drive, in which case the canned or wet motor pump has to be used.

Mechanical Seals for Water

For water, the mechanical unbalanced seal with synthetic rubber gaskets shown in Fig. 2 is

used for pressures from 29-in. Hg to 0 psig. and from normal cold water to 180 F.

A close clearance bushing is placed in the bottom of the stuffing box and the stuffing box is piped to a point in the pump where higher than stuffing box pressure exists.

Mechanical seals of the type shown in Figs. 7 and 8 are used where pressure varies from 0 to 200 psig. and temperature from cold to 180 F. The mechanical seal of Fig. 12 is used where the pressure is the same but the temperature range is 180 to 400 F.

An unbalanced seal can be used to about 100 psig. because water is a good seal lubricant. But for long seal life the unbalanced seal should be limited to a maximum of 100 psig. A close clearance bushing is not needed in the bottom of the stuffing box, but the stuffing box should be piped to a point in the pump where higher or lower pressure exists. Then flow is created past the seal to remove heat and assure that foreign matter will not collect around the seal.

High Temperature—The seal shown in Fig. 12 is used almost exclusively for high temperature water service.

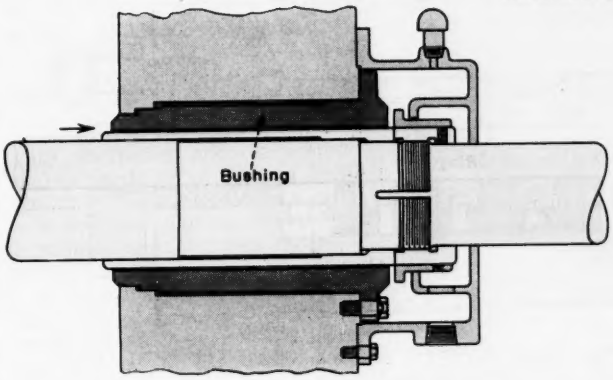
When water in the stuffing box exceeds 212 F. it will flash into steam as it goes across the rotating seal faces to atmosphere. When this condition exists the seal fails because the faces are being lubricated by steam. So water in the stuffing box must be cooled to below 212 F.—180 F. should be considered maximum, with 150 F. or below preferred for safety. The 180 F. maximum is suggested because the seal faces themselves generate some heat, raising the water temperature.

Two methods of cooling the stuffing box water are used. One is to inject cold or cool water to the stuffing box from an outside source permitting the use of a conventional mechanical seal (Fig. 7 or 8). The other method is to use a mechanical seal having a pump as an integral part of the seal to circulate water through a heat exchanger for cooling (Fig. 12). In the integral pump seal, slots are provided in the rotating seal face for pumping action. A channel and discharge port as well as an inlet port is provided in the seal flange.

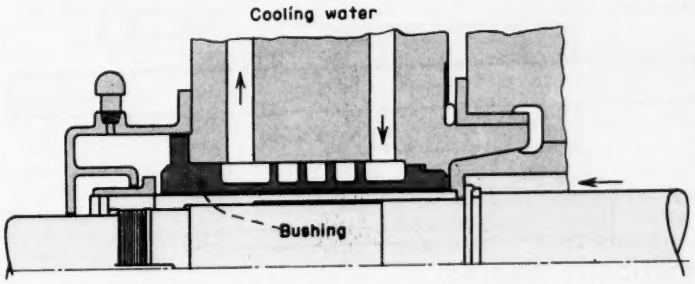
The mechanical seal shown in

Throttle Bushings

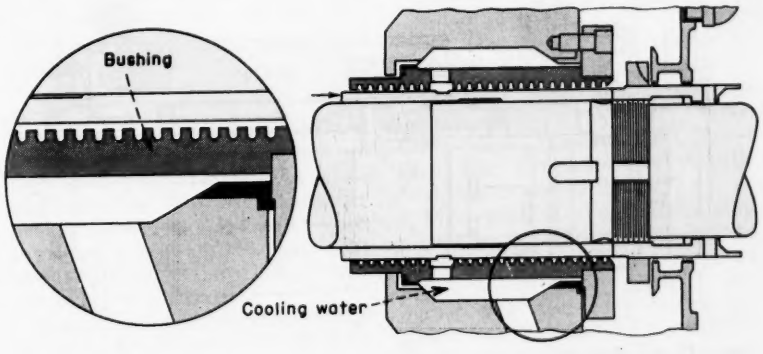
Uncooled Bushing Fig. 17



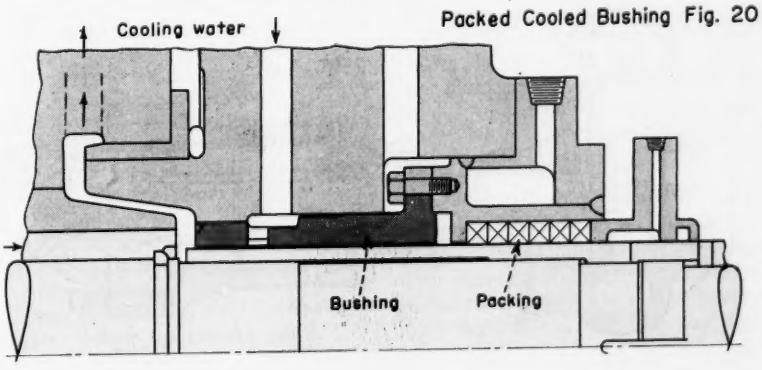
Cooled Bushing Fig. 18



Labyrinth Cooled Bushing Fig. 19

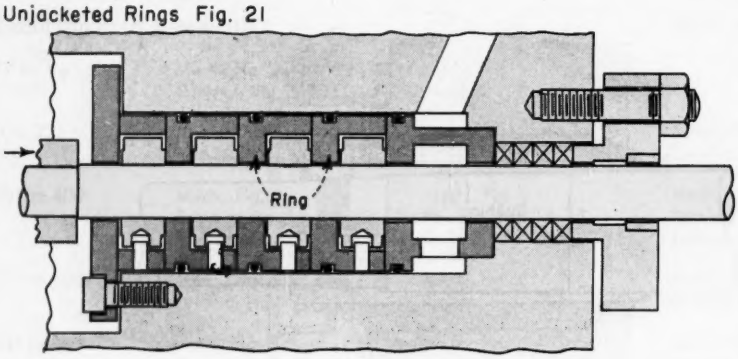


Packed Cooled Bushing Fig. 20

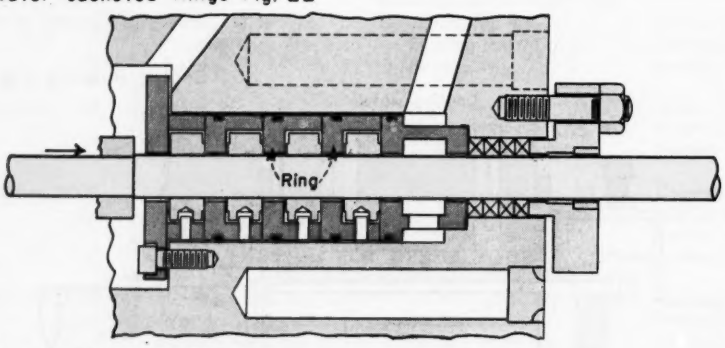


Floating Rings

Unjacketed Rings Fig. 21

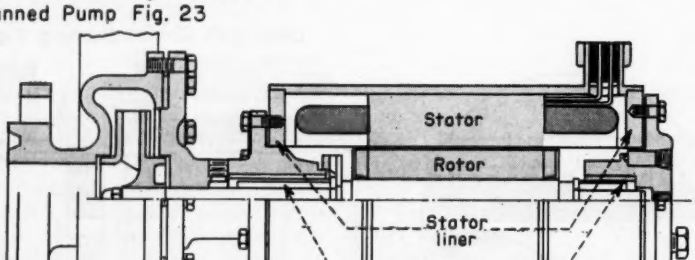


Water Jacketed Rings Fig. 22



Hermetically Sealed

Canned Pump Fig. 23



Wet Pump Fig. 24

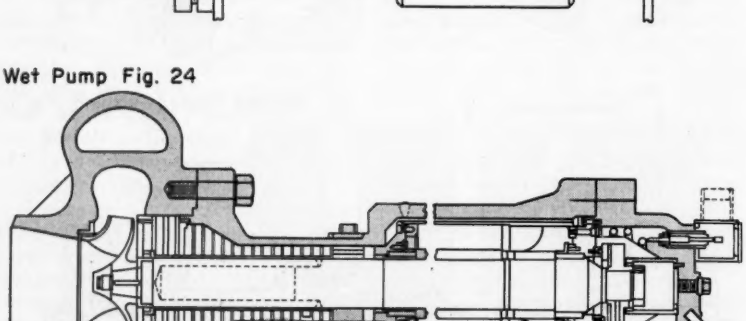


Fig. 8 is used for pressures to 1,000 psig. where temperatures range from cold to 180 F. This is a balanced mechanical seal equipped with synthetic rubber gaskets. Stuffing box should be piped to a point in the pump where higher or lower pressure exists so that a flow will be created past the seal.

For the high pressure range of 1,001 to 1,500 psig., mechanical seals of the type shown in Figs. 8 and 12 are used only as a basic design. This range covers the present day practical upper pressure limit for mechanical seals. It is important that only mechanical seals specifically designed for this pressure range be used.

Packing for Water

There are a large number of packing arrangements used with centrifugal pumps handling water. Reduced to a minimum, however, they usually fall into one or other of the four arrangements shown by Figs. 13, 14, 15 or 16.

Various types of packing are used, such as asbestos, flax, duck, Babbit, lead, etc. All are usually impregnated with a lubricant such as graphite. Bronze shaft sleeves can be used with the softer packings, but hardened sleeves or sleeves overlaid with material such as Stellite or colmonoy should be used with lead, Babbit or other metallic packings. Generally speaking, the softer packings are more popular in the lower pressure range of 200 psig. and below.

Packing arrangement shown in Fig. 13 is used for 29-in. Hg to 0 psig., and cold to 180 F.

A cage ring is placed in the center of the stuffing box with an equal number of packing rings on each side of the cage. Because the stuffing box is under vacuum, the cage ring should be connected to a point in the pump where higher than suction pressure exists. Water than under pressure will act as a seal to prevent air from entering the pump and as a lubricant for the packing.

If the pump is above the water level from which it takes suction, a grease fitting or grease cup is usually connected to the cage ring so that grease can be used for sealing and lubricating the packing. As as alternate arrangement, the cage ring can be piped to an external water source.

For pressures to 200 psig., the packing arrangement of Fig. 15 is used. With temperatures to 180 F. a stuffing box packed solid with packing can be used. If the water contains corrosive agents or is carrying abrasives, the arrangement in Fig. 14 should be used with clear water piped to the cage rings. Or, better still, the arrangement in Fig. 16 with clear water piped to both the throttle bushing and the cage ring at a pressure higher than stuffing box pressure.

In the pressure range of 0 to 200 psig. with temperatures above 180 F. the packing arrangement in Fig. 15 can be used, provided that the stuffing box is water jacketed to hold water leaking through the packing below its boiling point. If the stuffing box is not water jacketed then the arrangement in Fig. 14 is recommended with cold water flowing through the cage ring at a pressure higher than stuffing box pressure to remove heat.

Pressure Packing—The Fig. 15 arrangement does not include a cage ring and, therefore, is generally limited to temperatures below the boiling point of water, because water—not steam—must leak through the packing to provide lubrication. Under high stuffing-box pressure frictional heat created by the shaft or sleeve running in the packing will lower the useful temperature range of this arrangement still further.

In the pressure range of 201 to 300 psig. and temperature range of cold water to 150 F. the Fig. 15 arrangement can be used with success without a water jacketed stuffing box. With a water jacketed stuffing box the useful range of this arrangement can be extended to approximately 200 F. and sometimes higher. This will depend on the skill of the mechanic installing the packing, the absence of shaft runout in relation to the stuffing box bore and other factors contributing to a successful high pressure packing installation.

In the upper pressure-temperature range (201 to 400 psig.) the packing arrangement of Fig. 14 is usually used with cold water piped to and from the cage ring at a pressure higher than stuffing box pressure. This removes heat from the packing and shaft or sleeve and assures cool water lubrication for the packing. Sometimes water is piped from a higher pressure point in the pump to the cage ring and a heat exchanger is installed in the line to provide cool water under suitable pressure.

Throttle Bushings

In throttle bushings flow varies with clearance and is approximately in direct proportion to the length. Throttle bushings properly designed and constructed are a reliable and low cost means of controlling flow to atmosphere.

A disadvantage is the high leak rate of pumped liquid to atmosphere which increases as pressure increases. They are usually used in the pressure range above 200 or 300 psig. But are beginning to lose ground in favor of mechanical seals, particularly in the pressure range where mechanical seals have proven thoroughly reliable. Four throttle bushing arrangements are shown in Figs. 17, 18, 19 and 20. Temperature rather than pressure dictates the selection; however, it must be remembered that leakage through the bushing is high in comparison with other methods of sealing.

The throttle bushing arrangement of Fig. 17 is used for 201 to 3,000 psig. and temperatures between cold and 180 F. It is a typical throttle bushing with a collector device at the outboard end to direct leakage to a drain. A rotating deflector attached to the shaft sleeve or constructed as an integral part of the sleeve deflects the outcoming stream into a large area collecting chamber. A close clearance cowl and second drain is usually provided beyond the cowl to carry away any leakage that might flow past the deflector and through the clearance.

Water in the temperature range of 180 to 400 F. can be handled by throttle arrangement, such as those shown in Fig. 18 or 19. In the range of 180 to 300 F. Fig. 18 can be used; from 300 to 400 F. Fig. 19 is usually preferred.

The throttle bushing arrangement in Fig. 18 is similar to that of 17, except that the bushing is water jacketed for cooling.

In the range of 300 to 400 F. this throttle bushing arrangement usually cannot be used because the cooling effect of the water jacket is not sufficient to hold the leakage water below its boiling point.

In this range the throttle bushing design in Fig. 19 is usually used. Here cold condensate, or cold water, is injected at a pressure higher than stuffing box pressure to a cage ring located in the throttle at a point close to the pump or inboard end of the bushing. The condensate or cold water flows through an annular space surrounding at least part of the bushing for cooling, then through the cage and to the clearance between the shaft or sleeve and bushing.

The throttle arrangement of Fig. 19 is also used up to approximately 450 F. with corresponding pressure. It can be used for higher pressures and temperature, but the quantity of condensate or cool water needed for injection is usually considered excessive.

The throttle bushing shown in Fig. 20 follows exactly the same principal except that a packed stuffing box is provided at the outboard end.

This arrangement reduces the differential pressure across the outboard end of the throttle and consequently reduces the quantity of condensate or cold water injection needed. Back pressure should be held to practical limits for a cold water packed stuffing box—usually considered to be 400 psig. maximum.

Floating Rings

Floating ring assemblies are usually used in the 600 to 3,000 psig. range when leakage lower than that obtained with throttle bushings is desired.

First cost of the floating ring assembly is higher compared to throttle bushings. But savings in heat loss or water pumped and horsepower used to pressure the water lost through a conventional throttle bushing often justifies use of the floating ring assembly.

Floating ring arrangements are shown in Figs. 21 and 22. They are identical except that Fig. 22 is designed for injection of cold water while Fig. 21 is not.

Hermetically Sealed Units

Zero leakage units are more expensive than conventional pumps with conventional motors. For nonradioactive water, they are considered economical only in the ap-

Recommended Methods for Preventing or Eliminating of Leakage of Radioactive Water—Table III

Suction Psig.	Below 100F.	101 to 180F.	181 to 400F.	401 to 700F.
0 to 200	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12	
201 to 400	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12
401 to 600	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12
601 to 800	Canned pump, Fig 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12
801 to 1,500	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 8	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12	Canned pump, Fig. 23 Wet pump, Fig. 24 Mech., Fig. 12
1,501 to 3,000	Canned pump, Fig. 23 Wet pump, Fig. 24	Canned pump, Fig. 23 Wet pump, Fig. 24	Canned pump, Fig. 23 Wet pump, Fig. 24	Canned pump, Fig. 23 Wet pump, Fig. 24,

proximate pressure range of 1,500 to 3,000 psi. which at present is above the practical pressure range for mechanical seals.

One of two types are generally used: The canned motor type of Fig. 23 or the wet motor type of Fig. 24. Both units are generally similar except that the canned motor employs a non-magnetic sleeve placed in the metal stator bore and supported by the stator laminations to isolate stator windings from the pumped water. The wet motor has stator windings insulated with such material as polyethylene to withstand immersion in the water pumped. The isolating sleeve in the stator bore reduces efficiency of the canned type motor slightly below that of the wet type.

In both types, the motor rotor, radial bearings and pivot shoe, or plate-type thrust bearing run in the fluid pumped. Although it is generally conceded that water is inferior to oil for thrust bearing lubrication, bearing loading is much lower than would be in the case with a conventional pump with a shaft extended through the pump case wall.

In the conventional pump the shaft forms a piston having suction pressure on the pump end and atmospheric pressure on the out board or coupling end. This differential pressure multiplied by the shaft area in square inches where it pases through the pump case wall forms a direct load on the thrust bearing. In the hermetically sealed unit suction pressure usually exists on the pump end of the shaft and discharge pressure on the motor end. Differential pressure produced by the pump is usually low, resulting in low thrust requirements.

Thrust is often further reduced in this design by using differential pressure to act on pre-determined impeller areas balancing out at least part of the thrust developed by the pump. A thermal barrier is provided in both the canned and wet types to reduce heat transfer from the pump stream to the motor. This barrier usually consists of a physical separation (by an adapter) between pump and motor sections with a body of water of zero velocity.

Regardless of pumping temperature, water in the canned motor is cooled to approximately 150 F., in the wet motor to slightly lower than 150 F. At high temperatures this can be accomplished with an auxiliary impeller, furnished as an integral part of the motor shaft, which circulates water contained in the motor through an external heat exchanger for cooling.

Either the hermetically sealed canned motor or wet motor units should be used for pumping under high-pressure conditions (1,501-2,000 psig).

Handling Radioactive H_2O

Radioactive water, either light water or heavy water, is associated with nuclear reactors. Water in this classification is pumped in all ranges of temperatures and pressures. Leakage of light water to atmosphere constitutes a hazard because the leakage is radioactive and therefore dangerous to operating personnel. Heavy-water leakage to atmosphere is also hazardous because of radioactivity; furthermore, it is a high cost product requiring expensive treatment if it becomes contaminated by foreign matter or light water.

Because of these factors it is essential that leakage be held to a minimum, preferably zero, and that the pumping unit or sealing device be thoroughly reliable. Mechanical seals (Figs. 8, 12) and canned or wet type pumps are generally used.

Some engineers are reluctant to use the wet type sealed pump because radioactive water comes in contact with the stator winding insulation. In the canned type, radioactive water comes only in contact with metals and possibly carbon-graphite when used for bearing construction. However the wet motor pump is used in British nuclear power reactors.

Canned pumps for radioactive water are available up to several hundred horsepower.

Chemical Solutions

Chemical solutions are pumped at temperatures ranging from approximately −65 to +250 F., and at pressures ranging from approximately 29-in. Hg to 400 psig.

Some chemical solutions are mildly corrosive, some are violently corrosive, some carry abrasives and some form abrasives if other chemicals are inadvertently introduced.

The length of this article does not permit a discussion of the corrosive effect on materials. But again, corrosion protection is usually a matter of selecting proper materials of construction, or a matter of preventing the corrosive solution from coming in contact with the sealing device by injection of non-corrosive liquids.

The Table IV lists chemical solutions at temperatures from −65 to +250 F. and at suction pressures from 29-in. Hg to 400 psig. Mechanical seals and canned pumps are shown for all conditons of pressure and temperature; packing is listed for all temperatures and for all pressures from 29-in. Hg to 100 psig. Packing is sometimes used above 100 psig., but as chemical solutions are usually expensive and often hazardous, leakage to atmosphere at pressure above 100 psig. is usually considered excessive.

Mechanical Seals for Chemicals

The mechanical seals shown in Figs. 6 and 10 are used under conditions of 29-in. Hg to 100 psig. and −65 to + 250 F. Fig. 6 is an unbalanced seal with Teflon gaskets (Teflon is usually needed to withstand the corrosive effects of most chemical solutions). For solutions that are not injurious to synthetic rubber, mechanical seal of Fig. 7 can be used.

If the chemical solution contains abrasives, or forms abrasives, a close clearance bushing as in Fig. 1 can be installed in the bottom of the stuffing box. Clear liquid can be piped to the stuffing box to prevent abrasives from reaching the seal.

Fig. 10 covers a type of seal known as an unbalanced outside seal—the spring or springs and spring mechanism are outside the stuffing box.

Gasketing has always been a problem with chemical pumps, particularly before Teflon. Most of these units were designed without a shaft sleeve, primarily to eliminate the troublesome shaft sleeve gasketing problem.

Space for the seal inside the stuffing box is limited to packing thickness rather than to packing thickness plus shaft sleeve thickness which is the case with pumps designed to include a packing sleeve.

This space limitation has led to the use of the outside seal, where all parts are located outside of the stuffing box. Both balanced and unbalanced outside seals are available.

Disadvantages of this type of seal are that the pumped liquid cannot flow past the faces for cooling because the faces are outside of the stuffing box. And also abrasive particles in the pumped liquid can collect in the clearance space between the shaft and seal faces—centrifugal force tends to work these particles across the faces to atmosphere.

However, most of the seal parts are outside of the pumped liquid, which is an advantage from the corrosion point of view. But this feature also becomes a disadvantage with those solutions whose vapors combine with atmospheric moisture and become more corrosive than the pumped liquid.

Mechanical seal shown in Fig. 11 is known as an outside balanced seal and is usually used only in the pressure range from approximately 30 to 100 psig. when space is not available to install an unbalanced or balanced inside seal.

The outside balanced seal is balanced for higher stuffing box pressure but has all of the disadvantages (and advantages) of the seal shown in Fig. 10.

Balance is accomplished by firmly attaching a gasket shoulder to the pump shaft and gasketing the rotating face against this shoulder. Stuffing box pressure and atmospheric pressure act to balance each other.

Chemical solutions in the pressure and temperature range 101 to 400 psig., −65 to +250 F. are usually handled with the balanced mechanical seal shown in Fig. 5.

Teflon gaskets are used because of corrosion. However, a balanced

Recommended Methods for Preventing or Eliminating Leakage of Chemical Solutions—Table IV

Suction Psig.	−65 to +0F.	0 to 100F.	101 to 250F.
29 in. Hg to 0 psig.	Mech., Fig. 6, 10 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 6, 10 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 6, 10 Packing, Fig. 14 Canned pump, Fig. 23
0 to 30	Mech., Fig. 6 or 10 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 6, 10 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 6, 10 Packing, Fig. 14 Canned pump, Fig. 23
31 to 100	Mech., Fig. 5, 6, 10, 11 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 5, 6, 10, 11 Packing, Fig. 13, 14 Canned pump, Fig. 23	Mech., Fig. 5, 6, 10, 11 Packing, Fig. 14 Canned pump, Fig. 23
101 to 200	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23
201 to 400	Mech., Fig 5 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23	Mech., Fig. 5 Canned pump, Fig. 23

XUM

seal with rubber gaskets can be used for solutions that are not injurious to synthetic rubber.

Packing for Chemical Solutions

Packing for chemical solutions is steadily losing ground in favor of mechanical seals because of the higher loss of expensive chemicals and hazards connected with the escape of chemicals to the atmosphere.

Usually Teflon and Teflon-based packings or blue African asbestos packings are used in this service because of corrosion. However, other materials such as lead or Babbit are sometimes used, depending on the pressure, temperature and nature of the solution.

Two packing arrangements, Figs. 13 and 14, are used for chemical solutions. But Fig. 13 is the most popular for low temperatures (−65 to +100 F.). A cage ring is included to which grease, oil or non-corrosive liquid can be piped to lubricate the packing and partially prevent corrosive liquid from escaping to atmosphere.

Clear liquid, if piped to the cage ring, should be under pressure higher than stuffing box pressure so that a flow will exist through the packing into the pump as well as to atmosphere.

Fig. 14, however, is preferred in the temperature range from 150 to 250 F. It of course, includes a cage ring with in-and-out taps so that clear liquid or oil can be circulated to the cage ring to lubricate the packing and remove heat transferred from the pump and generated by the packing. With higher than suction pressure the clear liquid or oil will at least partially prevent corrosive liquid from escaping to the atmosphere.

Canned Pumps

A wide variety of canned pumps are available to handle many chemical solutions.* Corrosion presents a slight problem, but stainless steel, Monel, Hastelloy B, titanium are used in canned pumps. Construction materials are limited, however, by the requirement that stator sleeve must be of a non-magnetic material.

A primary limiting factor in the use of canned pumps for chemicals is the requirement that fluid inside the motor section must be clear and cool. Use of thermal barriers and heat exchanges overcome the temperature problems and various methods have been developed to keep particles out of the motor section. One common technique is to introduce a small flow of clear mother liquor to the rear of the motor section at a pressure 5 psi. higher than suction pressure. This flow continually flushes through the motor section to the pump, preventing particles from entering.

Canned pumps for chemical solutions are available in sizes from ⅓ to 7½ hp.

Liquid Metals

Liquid metals are usually pumped for one of two reasons: To transport metals from one location to another, such as from a melting kettle to an ingot mold or as a heat transfer means such as transfer of heat from a nuclear reactor.

Among the liquid metals pumped are lead, tin, magnesium, bismuth, sodium, sodium-potassium alloy (NAK), mercury and lithium. As a heat transfer medium either bismuth, sodium or sodium-potassium alloy are used, although work has been done with mercury and lithium and probably others. Liquid metals have excellent properties for heat transfer; system pressure is low at high temperatures, viscosity is low, and in most cases metals used for heat transfer weigh less than water, requiring less horsepower for pumping.

Because of their low viscosities lubricating qualities are comparatively poor. However, unless contaminated with foreign matter, liquid metals are non-abrasive. Table V shows liquid metals in the pressure range of from 0 to 100 psig.—and temperature range from 250 to 1,600 F.

Pumping From Open Kettle—Pumps for transporting liquid metals from one location to another have been used for many years, usually a submerged pump similar to Fig. 25 is used. The pump is installed in an open kettle or vessel full, or partly full, of liquid metal.

Pumping in Closed System—When used as a heat transfer medium, liquid metals are circulated in a closed system. Care must be taken to prevent the liquid from coming in contact with atmosphere because of the danger of oxidation.

Gases liberated by sodium and sodium-potassium alloy during oxidation are extremely hazardous to operating personnel and can cause fires and/or explosions if allowed to come in contact with moisture-carrying atmosphere. Also, an accumulation of oxidation products in the closed system will result in reduced heat transfer efficiency and greatly increase corrosive action. For these reasons, leakage of liquid metals to atmosphere must be held to zero. These restrictions have led to a great deal of development work which is still in progress. At present five pump selections are available.

- Electromagnetic pumps.
- Frozen seal pumps (Fig. 26).
- Gas-filled motor pumps.
- Gas-filled pump with mechanical seal.
- Canned motor pumps (Fig. 23).

Electromagnetic Pumps

By the end of 1949 England and America were both actively engaged in the development of electromagnetic pumps for nuclear reactors. The electromagnetic method of pumping can theoretically be applied to any fluid which will conduct a current of electricity; however, the efficiency of pumping decreases as the resistivity of the fluid increases. Efficiencies obtained to date with these units are low, 35% appears to be the maximum obtained. But development work is still in progress.

Frozen Seal Pumps

The frozen seal pump (Fig. 26) is one of the newest means of preventing leakage of liquid metals to atmosphere. The pump is of vertical construction having an airtight column between the pump proper and the driving motor through which the drive shaft con-

*Also in the category of zero leakage pumps are the submerged pumps which use a hydraulic seal. This type (Fig. 25) is used to a limited extent in the chemical industry, particularly for pumping sulfuric acid. Also, the diaphragm pumps (Oliver, Lapp and Shriver) which are mechanically, pneumatically or hydraulically actuated, can be considered as "packless" pumps. They are used primarily on slurries.

nects the pump impeller to the motor.

The frozen seal is located where the shaft extends through the pump case wall. An inert gas, nitrogen or helium, is introduced to the column to prevent atmosphere from reaching the seal.

In effect the seal is a throttle bushing in whose clearance liquid metal is allowed to freeze while the shaft is rotating, resulting in a clearance sufficiently close to prevent escape of liquid. A coolant is circulated through a jacket surrounding the throttle to obtain the proper freezing temperatures. Efficiency of this unit is higher than that obtained from the electromagnetic pump and permits the use of electric motors, steam turbines and other drivers.

Gas-Filled Pumps

The gas-filled motor pump is a vertical unit with a column similar to that of the frozen seal pump. The pump case, column and motor housing form a single gasketed pressure vessel.

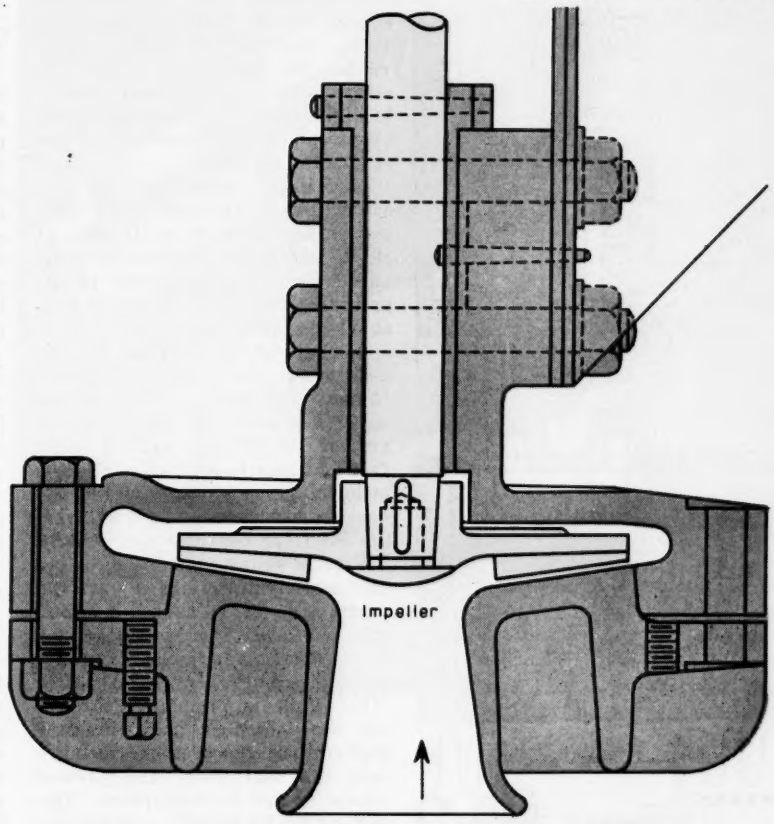
It is so installed that the liquid level in the system falls at a point in the column between the pump and motor. A conventional throttle bushing is installed where the shaft extends through the pump case wall. Liquid metal is allowed to raise through the throttle bushing clearance into the column where the liquid level is controlled by bleedoff to suction and by the inert gas used to pressure the motor and column. Efficiency of this unit is good, but the choice of drive is limited to the electric motor.

The gas-filled pump with a mechanical seal is similar in construction to the gas-filled motor pump. A mechanical seal designed for sealing gas is installed at the top of the column where the motor shaft connects to a standard driver.

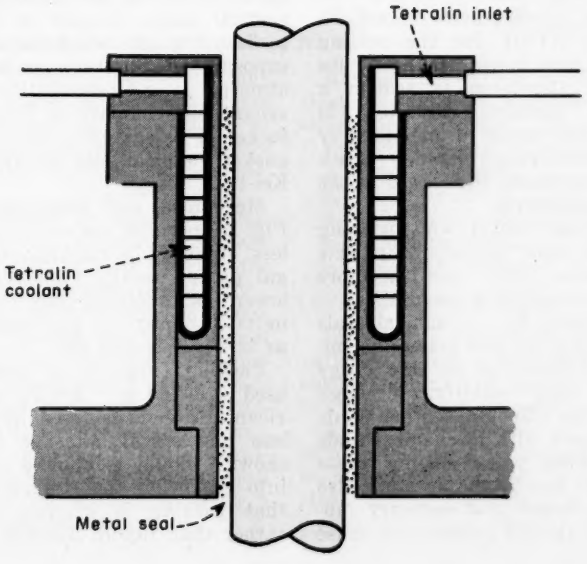
Liquid Gases

Among the liquid gases in the temperature-pressure range 0 to 150 psig., −100 to −320 F. are liquid oxygen, nitrogen, methane and ethane-methane mixtures. These liquids are usually pumped in the sub-zero range to obtain a low system pressure close to the liquid vapor pressure.

Liquid Metal Seals
Submerged Pump Fig. 25

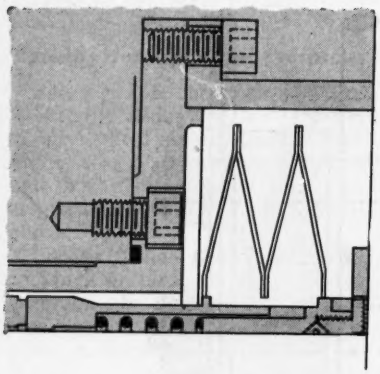


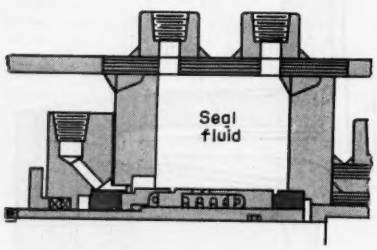
Frozen Seal Fig. 26

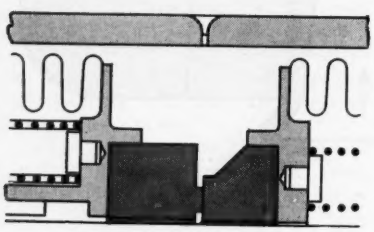


Low Temperature Seals

Figs. 27, 28, 29







Careful consideration should be given to NPSH for the sealing device, unless a gas sealing device is used. Corrosion is seldom a problem because corrosion is usually the result of moisture or moisture-carrying vapors which are automatically eliminated at the low temperatures.

The best gasket and packing materials lose resiliency in this temperature range and therefore must be considered impractical.

Lubricants for mechanical seals and packing are also generally considered impractical in this range because they solidify, although some of the silicon and other fluids can be used with mechanical seals and packing when sealing these liquids in gas form. It must also be remembered that ordinary lubricating oils and greases can cause a violent explosion if combined with liquid oxygen.

Materials of construction for the sealing device must be limited to those having suitable impact values for the temperatures involved. These are usually limited to high-nickel alloys, certain of the bronzes, and aluminum or certain aluminum alloys.

Mechanical seals, packing, and canned pumps are used in the pressure range from 0 to 10 psig. at all temperatures. Mechanical seals and canned pumps are used in the pressure range from 11 to 150 psig. at all temperatures.

Mechanical seal (Fig. 27) is used where the liquid is in direct contact with the pump side of the seal. Because of low temperatures, neither stationary nor rotating face gaskets are used. Metallic bellows, lapped joints and metal gaskets are used instead to avoid the need for conventional gaskets.

Fig. 28 shows a double mechanical seal installed in a vertical pump. Liquid is caused to flash into gas below the seal assembly by circulating air or warm gas through the jackets. Silicon or other fluid is circulated through the seal chamber at a pressure higher than gas pressure to lubricate the seal faces and prevent escape of gas to atmosphere. This seal is usually made of conventional gasket materials such as Teflon or Kel-F, since the temperature at the seal is within the range of these materials.

Fig. 29 shows a mechanical seal designed to seal gas installed in a vertical pump. Liquid is allowed to flash into gas below the seal by exposure of the seal chamber to atmosphere or by circulation of air around the chamber or through a jacket. This seal uses conventional gasket material such as Teflon or Kel-F.

Mechanical seal arrangement of Fig. 27 permits use of a more or less standard horizontal centrifugal pump, usually resulting in a lower cost pumping unit than the units designed for gas seals such as in Figs. 28 and 29.

Packing (Fig. 15) is sometimes used at −100 to −300 F. As lubricants are considered more or less impractical, no cage ring is shown. Liquid is allowed to flash into gas below the stuffing box so that packing is exposed to gas rather than liquid. Usually Teflon impregnated with graphite is used to pack the stuffing box.

Canned Pumps

For handling low temperature liquids, the canned pump is used, with modifications. The problem here is to keep the liquid from flashing in the pump. One modification uses a section of small tubing which is tapped into the discharge line, wrapped around the motor section, then taken to a low pressure point. Heat of vaporization, as the liquid turns to gas, cools the motor.

Also, reverse circulation can be used. The dynamic balance holes in the impeller are first closed. A line is then taken from the port in the rear bearing housing. Cooling fluid circulation is then from the impeller, through the rotor chamber, out the rear bearing housing, to a low pressure point.

More Designs Needed

There is no doubt that many seals and pumps are available to help the chemical engineer with his pumping problems. But further developments must keep pace with new and more difficult operating conditions. Even now, many of the new designs have their limitations in cost, pressure or capacities. No one method or technique, in the foreseeable future, will answer all problems or operate under all conditions. But many will make life easier for engineers concerned with pumping liquids.

Acknowledgement

The author wishes to thank the following companies for their help and cooperation: Crane Co., Duralmetallic, Seal-ol, Byron Jackson, Ingersoll Rand, Westinghouse, General Electric, Allis Chalmers, Hayward Tyler (England), United Centrifugal Pumps, Atomics International, Koppers Co., Chempump, Reliance Electric.

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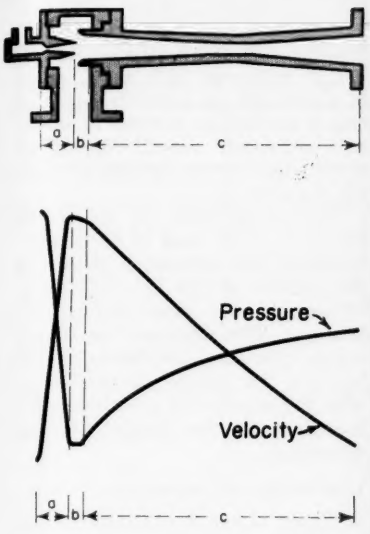
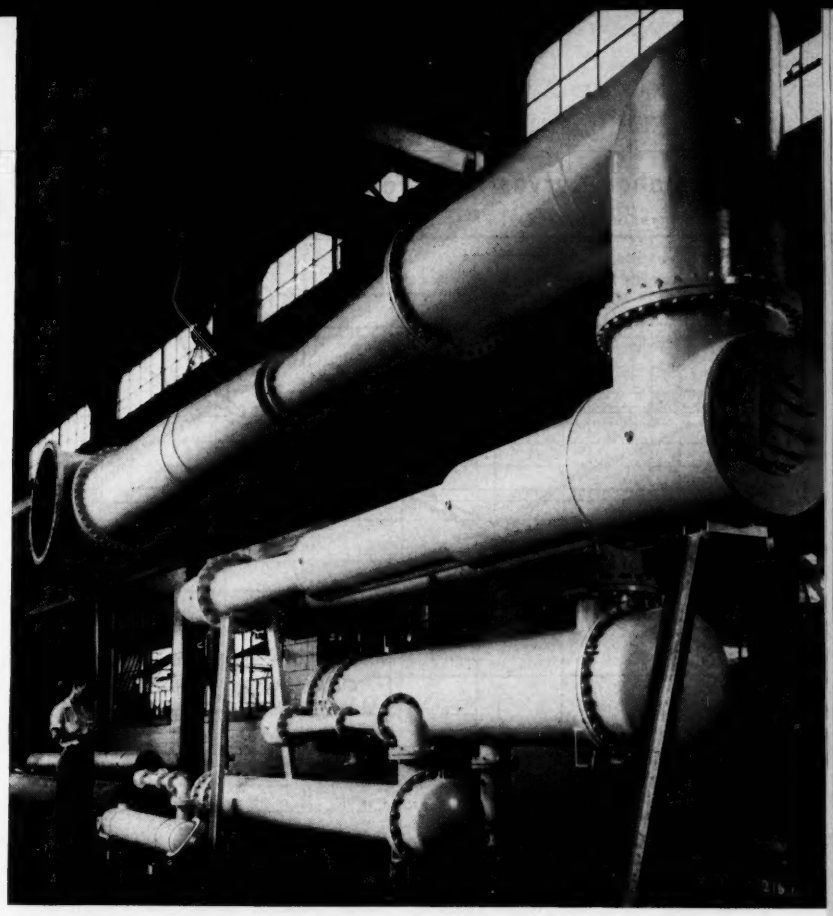


From fundamental ejector principles to the complex industrial arrangement . . .



Ejectors Give Any Suction Pressure

Recent tests on multistage ejector systems will simplify your task of designing vacuum-producing equipment for any pressure.

F. DUNCAN BERKELEY, Graham Manufacturing Co., Inc., Batavia, N. Y.*

Because of overlapping performance, it's often a lengthy problem to arrive at the most economical design of an ejector. In practically every new application of high vacuum, we find it necessary to investigate thoroughly the many available means of producing vacuum to reduce equipment and operating costs to a practical and profitable level.

But the giant strides of technology have brought to light an entirely new concept in the study of vacuum-producing apparatus. Recent tests of 5-stage and 6-stage systems indicate that steam ejectors have carved a unique and popular place in industry where large volumes of gases must be evacuated—and they can produce almost any desired suction pressure.

In addition, by using only certain parts of a multistage system, one installation can serve the whole range of test conditions.

The simple principles on which ejectors operate and the almost universal use of steam and compressed air in plants of all kinds have given the ejector many advantages over other vacuum pumps. However, in spite of simple operating principles, the most economical design of an ejector is often a lengthy problem.

Among the variables that you should consider in selecting a particular design of steam ejector are:

1. Suction pressure required.
2. Steam available.
3. Water available.
4. Fluid to be evacuated.
5. Equipment cost.
6. Installation cost.

LET'S DISCUSS PRINCIPLES

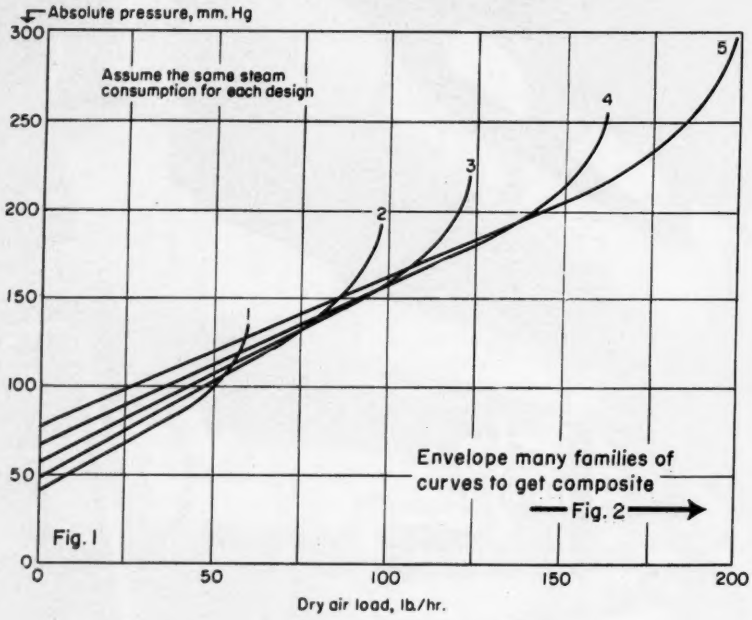
In order to show how these six variables affect the design of a steam ejector, let's discuss briefly the principles of ejectors.

All ejectors operate on a common principle. By means of a high-velocity jet of propelling steam, air or other fluid, a gas or vapor—or even finely divided

*This article is based on a talk by Mr. Berkeley before the Chicago section of ASME in March, 1956.

Meet your author on p. 329.

Performance Curves for a Family of Ejectors



solids—can be entrained and caused to flow at high velocity along with the motive stream.

Directing the combined stream into the diffuser section of an ejector converts velocity into pressure. In effect, the high-velocity combined stream pushes against the discharge pressure of the ejector and maintains a pressure difference between the suction inlet and the discharge of the ejector.

The line sketch above illustrates approximately a typical conversion of pressure to velocity in the nozzle of the ejector and the conversion of velocity into pressure in the diffuser.

In all flow processes there are energy losses. The ejector is no exception.

Let's suppose that the flow process within an ejector is 100% efficient. At 100% efficiency, it would be possible for an ejector handling no load to convert the energy of pressure of the motive gas to velocity in the nozzle and then convert this energy of velocity back to pressure in the diffuser so that the discharge pressure of the ejector would equal the initial pressure of the gas.

Such ideal flow processes can be approached in a well-designed flow section, where the expansion ratio of the gas is not too great. However, the jet velocity we achieve in this instance is not very high and there is relatively little velocity energy available to entrain a secondary gas.

Under normal circumstances the expansion process in the nozzle of a well-designed ejector is almost always a fairly efficient part of the over-all flow process. So we get very small energy losses in the nozzle. However, as jet velocity is increased by altering the design, the task of efficiently converting velocity back into pressure becomes increasingly difficult. It is in this part of the flow process of an ejector that we lose some of the energy.

When we reach supersonic-flow velocities, shock waves are unavoidable in converting velocity back to pressure. These shock losses in the diffuser become more severe as the diffuser entrance velocity (velocity of compression) is increased. This, in turn, limits the discharge pressure to which the velocity energy can be converted.

Therefore, if we fix the discharge pressure—as it is for a single-stage ejector discharging to the atmosphere—there is a practical limit to the velocity of compression for which an ejector can be designed. And in the case of an ejector that is evacuating a closed vessel with no in-leakage, there is a limit to the absolute pressure that a particular number of stages will ultimately reach, even if we permit the ejector system to operate forever.

Suction pressure of an ejector handling a gas load is further affected by the surrender of part of the energy of the jet velocity to entraining (or accelerating) the load gas. This explains why the absolute pressure increases as the load to the ejector increases and why the number of ejection stages increases as the design pressure decreases.

USE WATER TO CONDENSE

Where water is available at reasonably low temperatures, it's common practice to condense the steam from each stage of a multistage ejector in an intercondenser to reduce the load on the successive stage.

Such a design reduces the steam required to handle a given load as compared to a multistage noncondensing ejector, where each preceding stage discharges directly to the succeeding stage.

However, an intercondenser increases the initial cost of an ejector and the problem of selection is one of operating cost vs. initial equipment cost. Because every ejector application has its own economics, we can't set down a simple rule to guide the selection of the correct design. For a particular application, though, a buyer of ejectors often knows from experience the limitations on steam, water or money that he faces.

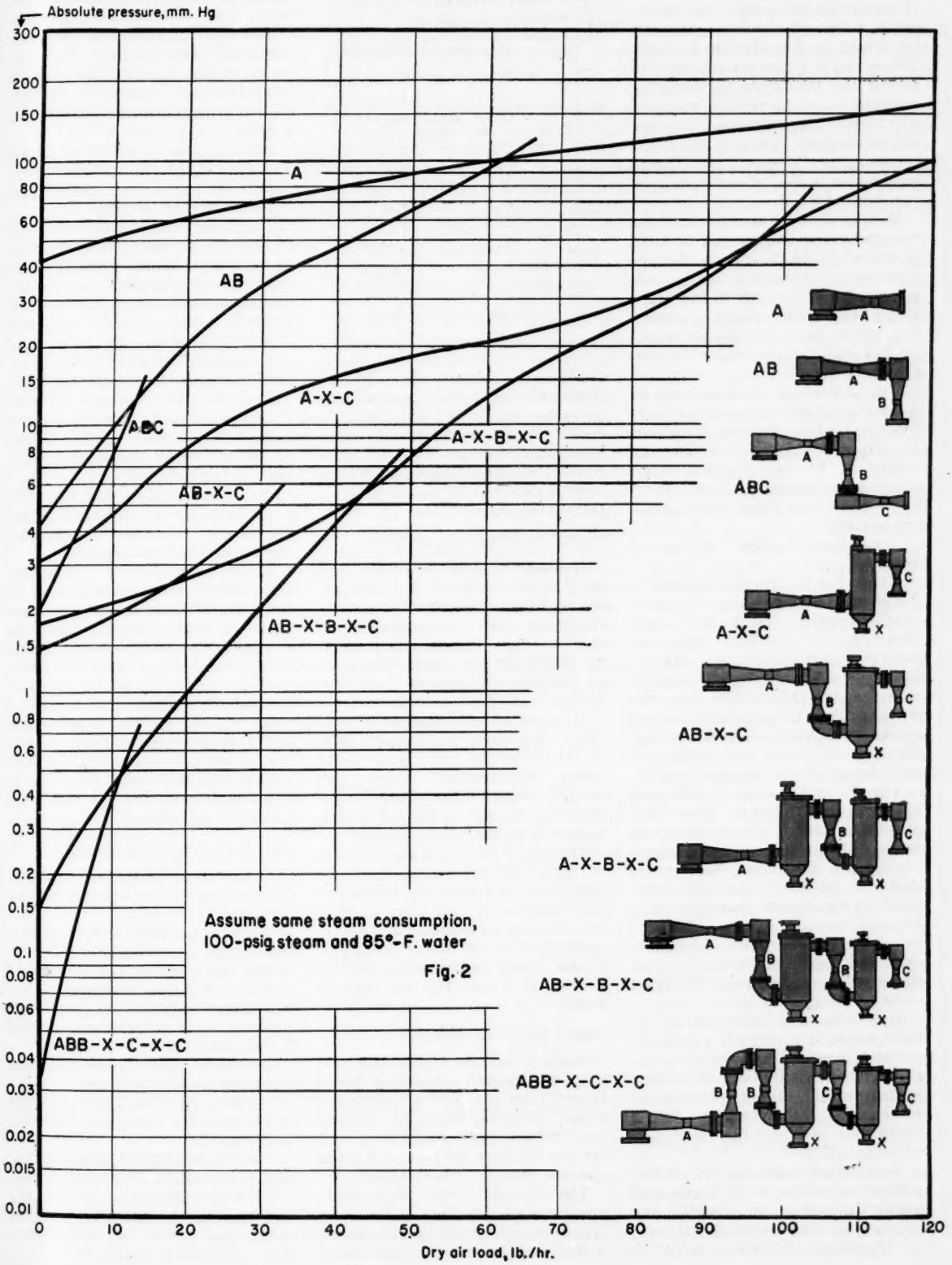
A FAMILY OF DESIGNS

Since an ejector can be designed for high efficiency at some particular absolute pressure, each design will yield a different performance curve. Fig. 1 indicates the performance for a family of designs of 1-stage ejectors using the same quantity of steam in each design.

The envelope of this family of curves is the curve of all possible points of maximum efficiency for 1-stage ejectors. If we plot many graphs similar to that shown in Fig. 1 for many 1- to 5-stage ejector systems, the envelopes of the individual graphs will lead us to the over-all plot, shown as Fig. 2 on the facing page.

Fig. 2 plots absolute pressure vs.

Steam Jets Serve the Entire Pressure Range



Assume same steam consumption, 100-psig. steam and 85°-F. water

Fig. 2

air load for all the possible points of maximum efficiency covering the entire range of absolute pressures for which we usually use ejectors. The data are based on ejectors designed for maximum air-handling capacity at a particular pressure and include all of the most common ejector designs based on one steam consumption (100-psig. steam) and condensing water at an inlet temperature of 85 F.

We can see that as many as three noncondensing stages can be used practically. In 3-, 4- or 5-stage ejectors it's necessary to use noncondensing stages where the interstage pressure at which a condenser would have to operate would be too low for the water to condense the steam.

Fig. 2 permits a comparison of capacities of the various designs of ejectors that can be used for a particular suction pressure. For instance at 10 mm. Hg abs., four designs are available. They are:

- A 2- or 3-stage noncondensing system.
- A 2- or 3-stage condensing system.

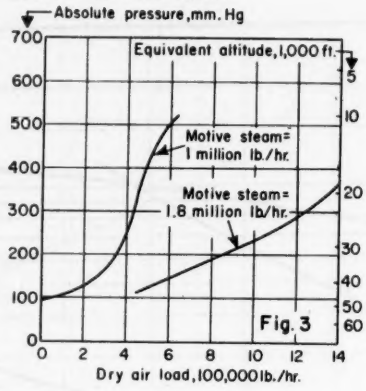
From Fig. 2, we can see that a 2-stage noncondensing ejector would require about 9% more steam/lb. of air load than the 3-stage noncondensing ejector. However, the 3-stage ejector would cost considerably more than the 2-stage. Thus, there probably would not be enough advantage at 10 mm. Hg abs. to justify the additional initial cost of the 3-stage system.

The 2- and 3-stage condensing ejectors would require only 43% and 19%, respectively, of the steam required for a 2-stage noncondensing ejector. Of course, their initial costs would be higher and they need a supply of cooling water. If long periods of operation are required, however, the steam savings will undoubtedly more than make up for the difference in initial costs.

If we know the utility and equipment costs, it's a simple matter to calculate how many hours of operation will be required for the steam savings of the higher-cost designs to balance the increased initial equipment cost and increased cost of installation.

Installation costs can be an important consideration if steam and water lines must be extended any appreciable distance to the ejector, or if special structures must be

Jets Test Aircraft



erected to support the ejector. Ordinarily, a 1-stage ejector can be supported by the equipment on which it is installed. However, multistage ejectors with intercondensers require some kind of support if they are to be elevated, as they often are.

WATER TEMPERATURE EFFECTS

If condensing water colder than 85 F. were used for our comparison in Fig. 2, all of the curves representing the performance of ejectors that require water would be shifted to the right, indicating an increase in capacity for these designs.

If water warmer than 85 F. were used, the shift in these curves would be to the left. And if the water temperature were high enough, some of the curves would move far enough to the left to disappear from the graph entirely.

The effect of water temperature is more critical on ejectors designed for low absolute pressures. For example, in a 4-stage ejector, the increase in capacity for 65°-F. water over 85°-F. water for a particular steam consumption will be greater at 1 mm. Hg abs. than at 4 mm.

STEAM PRESSURE EFFECTS

Steam pressures higher than 100 psig. will permit designing for a larger capacity for a particular steam consumption. A greater benefit from high steam pressures can be realized in 1- and 2-stage ejectors than in other designs.

The benefit from high-steam pressures becomes less as the absolute pressure for which the ejector is designed decreases. Single-stage ejectors designed for absolute pressures less than 200 mm. Hg abs. cannot operate efficiently on steam pressures below 25 psig. However, initial stages of multistage ejectors can often be designed to operate efficiently on steam pressures below 1 psig.

And it is not uncommon to use an extra stage for an ejector designed to operate on steam pressures as low as 15 psig.

It is very important that the steam used to motivate ejectors be at least dry-saturated steam. Small amounts of moisture can be removed successfully by using a good, properly sized steam separator which will remove 98 to 99% of the moisture entering the separator. Moisture in steam is usually difficult to detect without the careful use of a throttling calorimeter. Steam calorimeters are laboratory instruments and are seldom available in the field.

Many an engineer has had difficulty proving or disproving that the quality of steam is affecting the operation of an ejector.

Steam separators are relatively inexpensive and should always be installed with an ejector wherever there is any possibility that the steam to the ejector contains moisture. Steam lines from the boiler to the ejector should be insulated —especially where the length of piping is over 10 ft.—because if a boiler is generating steam that is just barely dry-saturated, it will take a relatively small heat loss to cause moisture to be present in the steam at the ejector.

WHY USE INTERCONDENSERS?

Condensing ejectors are available in both surface or barometric (direct-contact) types.

We have not shown the economic considerations of water requirements on Fig. 2, but we should mention that the barometric intercondenser requires slightly less water to operate than the surface intercondenser.

Barometric intercondensers have these principal advantages:

- They cost less than a surface intercondenser designed for the same service.
- If used with a barometric leg, they don't need a condensate pump.
- They seldom require cleaning and can handle corrosive or tarry substances with relatively little wear or loss in efficiency.

• The vapors come in intimate contact with the condensing water in a scrubbing action that removes soluble vapors, gases and suspended solids from the noncondensables.

The disadvantages of barometric intercondensers are:

• Condensate mixes with the cooling water and cannot be recovered for use as hot, pure boiler feedwater.

• If a pump, instead of a barometric leg, is used to remove the water, it must handle the condensing water in addition to the condensate. This requires a larger condensate pump than for a surface intercondenser.

HOW TO SELECT EJECTORS

By using Fig. 2 we can make the correct selection of a steam ejector to handle noncondensable gases. In cases where a portion of the load to the ejector is a condensable vapor, the data plotted on Fig. 2 are not applicable and it's necessary to analyze the particular operating conditions to determine the correct ejector design for optimum economy.

In some instances we can reduce the load to the ejector considerably by using a precondenser to condense a large portion of the vapors before they reach the ejector. Often the absolute pressure is too low to use a precondenser and it's necessary to compress or boost the vapors to a pressure where a large part of the condensing can be done in an intercondenser. This permits the use of small secondary ejectors to complete the compression of noncondensable vapors.

For a multistage ejector handling air or other noncondensable gases, there is a particular design that will require a minimum of steam and water for its operation. Using more water will not give any appreciable steam savings.

In cases where a large portion of the load is a condensable vapor, there is a range of steam and water combinations which can be designed for and the relative costs of steam and water will determine the best design. The cost of ejector equipment will usually not vary appreciably within the range of steam and water requirements possible. So the problem in these instances is one of economics of operation where the initial cost of the ejector equipment is fixed.

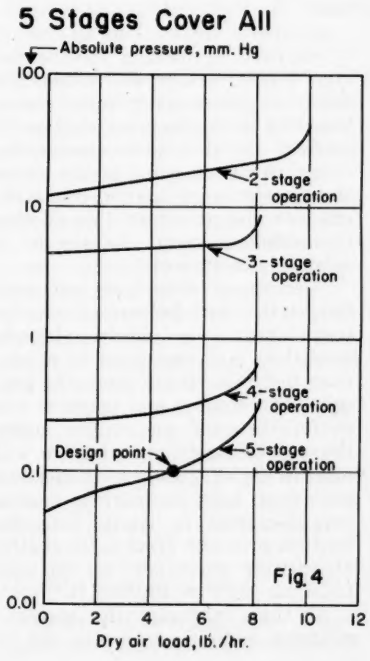
Performance of ejectors operating on fluids other than steam cannot be analyzed by using Fig. 2, since the thermodynamic properties of the motive fluid will vary the design of an ejector.

OPERATING CHARACTERISTICS

Each stage of a multistage ejector has the same basic operating characteristics as a 1-stage ejector. Therefore, to understand the operation of a multistage ejector, we should first discuss how 1-stage ejectors operate.

Single-point design ejectors are most sensitive to changes in discharge pressure. If the discharge pressure of an ejector exceeds its minimum stable discharge pressure, the operation will become unstable and the capacity will no longer be a function of the absolute pressure. Stable operation can be attained either by increasing the steam flow or by decreasing the discharge pressure.

In a nozzle of a fixed design we have to raise the steam pressure to increase the steam flow. The minimum steam pressure at which the ejector regains stability is called the "motive steam pickup pressure." The motive steam pickup pressure is a direct function of the discharge pressure. At the higher discharge pressure, the ejector will regain its stability once the motive steam pressure is increased to the pickup pressure; but the absolute pressure for a particular load will be increased slightly from what it was at the lower discharge pressure.



For every discharge pressure in a single-point-design ejector there is also a minimum steam flow below which the operation will be unstable. For a nozzle of fixed design, we have to decrease the steam pressure to reduce the steam flow.

The maximum steam pressure at which the ejector becomes unstable is called its "motive steam break pressure." For a particular discharge pressure and load the motive steam break pressure is, of course, below the motive steam pickup pressure. At steam pressures between the break and pickup pressures, the ejector may operate stably or unstably depending on which direction the steam pressure is changing.

If the steam pressure is being increased from a point of instability, the ejector will operate unstably until the pickup pressure is attained; and if the steam pressure is being decreased from a point of stability, the ejector will operate stably until the break pressure is reached.

The terms "break" and "pickup" pressures are also used in reference to the discharge pressure of an ejector—for the pressures at which ejector operation becomes unstable and stable, respectively. These critical discharge pressures are a function of the steam pressure and load for a fixed design.

Some ejector stages have no motive steam break and pickup pressures because of the low ratio of the discharge pressure to suction pressure over which they operate, or because they are designed to eliminate this characteristic. In these ejectors the capacity varies directly with steam pressure over certain operating limits.

Variations in ejector designs permit a variety of operating characteristics in ejectors. Certain of these may be essential to the success of an ejector for a particular application.

SINGLE-POINT DESIGN

If only one load and vacuum are required for a particular application, single and multistage ejectors can be designed specifically for one condition. This saves steam.

Occasionally, however, single-point design ejectors are not always stable at very light loads or at loads slightly in excess of design load. An ejector of this design is not necessarily undesirable if the ejector always operates at the exact design conditions. This, of course, depends on whether or not it's possible to determine accurately the load on the ejector before it is designed.

Close designs can often result in substantial steam and water savings in large systems. However, we usually can't determine exact operating conditions prior to design. For this reason single-point designs are not in general use.

More often the design condition for an ejector can only be estimated approximately and we often arbitrarily select a design with a reasonable safety factor. Here the ejector is designed for stable operation at light loads as well as at its so-called design point to insure trouble-free operation if the load is more or less than that estimated originally.

A long range of stability from light loads to beyond design load will require more steam than the single-point design ejector. The greater the range of stability required, the more steam required. For the sake of steam and water economy, ejectors should not be designed for stability any farther in excess of design load than is deemed necessary for safe limits.

With low compression ratios, we can design an ejector that is inherently stable at light loads as well as at loads far in excess of design load. This requires little more steam than in the single-point design, and occurs when the suction pressure for which the ejector must be designed does not fall at the extreme low-absolute-pressure range of a particular ejector.

For instance, a 1-stage ejector designed for 50 mm. Hg abs. would be more sensitive to off-design conditions than a 1-stage ejector designed for 100 mm. The 100-mm. ejector would have stable characteristics at light loads and loads in excess of its design point with practically no increase in steam over the single-point design. In contrast, the 50-mm. ejector would need more steam over the single-point design to achieve stability at very light loads and loads in excess of its design load.

MULTIPOINT DESIGN

Occasionally an ejector must operate alternately at two or more conditions of load and vacuum. Then we must design the ejector for the most difficult conditions (or the conditions that call for the largest ejector). The other conditions will then fall within the performance curve of the larger ejector.

An ejector of this type is sometimes considerably oversized for some of the required conditions in order to achieve the most economical design from the standpoint of initial cost. If operational economy is important at each of the conditions, it may be desirable to use two separate ejectors to achieve efficiency at both operating points.

It's possible in some applications to provide an ejector for two or more different operating conditions —with maximum efficiency at each point—by providing a steam nozzle or diffuser designed for each condition. In changing operations from one condition to the other, we only have to shut down the system long enough to change the nozzle or the diffuser.

Often, substantial steam savings can be realized without buying two ejector systems.

Designs of this kind have found applications in the recompression boosters for evaporators and large ejectors for high-altitude wind tunnels.

In certain applications an ejector is required to meet a specific design curve. Then we sometimes must use considerably more steam than for a single-point design to produce the desired characteristic curve. At some point in the curve the ejector is, of course, relatively efficient and at either side of this high-efficiency point the ejector is relatively inefficient.

Ejectors of this type are used frequently by jet-aircraft-engine test laboratories where altitude conditions are simulated in a vacuum test cell. These test cells permit us to observe and measure the performance of an engine under the actual conditions that it will meet in the sky. Enormous ejectors have been built for various engine manufacturers to handle the combustion products from a jet engine at vacuum corresponding to altitudes as high as 100,000 ft.

At these altitudes the absolute pressure dwindles to 8 mm. Hg or less. Ejectors designed for these applications must cover a wide range of operating conditions with a minimum steam consumption.

Fig. 3 shows typical performance curves of some large ejectors now being used by aircraft companies to test engines at altitudes from sea level to 40,000 ft.

USE ONLY SOME STAGES

It's possible to meet a large variety of operating conditions economically with multistage ejectors by operating only some of the stages at a time.

All ejectors have at least as many different performance curves as they have stages. For a particular stage to operate, all the succeeding stages must, of course, be operating also. Fig. 4 indicates a set of performance curves for a typical 5-stage ejector. By furnishing suitable automatic controls, practically all points within the envelope formed by these curves can be reached by the ejector. Thus, the ejector can cover an entire area of possible operating conditions.

On large ejectors, the cost of automatic controls may be paid for many times in steam savings.

Six stages of compression have lengthened the range of operation of steam ejectors down to absolute pressures as low as 5 microns of Hg (0.005 mm. Hg). Commercial designs are available and should often be used in place of other kinds of vacuum pumps.

Chief advantages of ejectors over other kinds of vacuum pumps are:

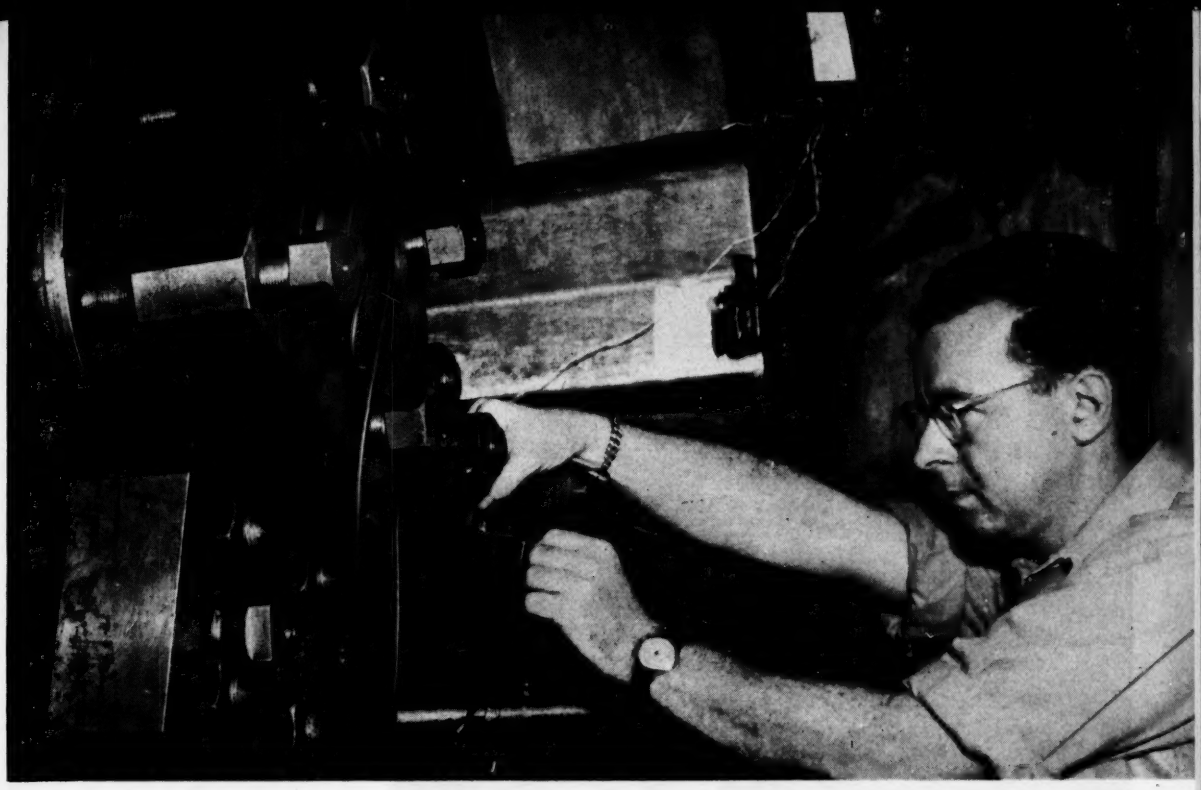
- Rugged and simple construction.
- They can handle enormous volumes of gases in relatively small sizes of equipment.
- Require less maintenance.
- Simple operation.

Other considerations, of course, may outweigh these advantages. Or perhaps the unavailability of a suitable motive fluid or water will rule out the use of an ejector for a particular application.

You'll need an over-all picture of your requirements and utilities to select the best vacuum pump for your needs.

ACKNOWLEDGMENT

We gratefully acknowledge the comments and suggestions of H. M. Graham and the engineering department of Graham Manufacturing Co.



How to Check Equipment Quality

To assure safety and serviceability in your new chemical plant, use non-destructive techniques to check quality of materials and equipment. It's an engineering followup that pays.

C. J. VEITH, E. I. du Pont de Nemours & Co., Wilmington, Del.*

On 28 sites in 15 states, our company currently is erecting new chemical-plant facilities. Such widespread, heavy construction calls for an unending stream of materials and equipment to be delivered from all over the United States and occasionally from Europe.

To assure that these materials and equipment meet quality requirements, we use nondestructive methods to check out specified characteristics. Such quality control produces plants that operate continuously and efficiently. And it produces them on time within the allotted project cost.

You can visualize the scope of this control job when you realize that nearly all the known materials of construction are found in the widely varied types of chemical, mechanical and electrical equipment installed by us since World War II. Tied into many different processes, these units perform under conditions ranging from:

- Almost complete vacuum to extremely high pressures.
- Subzero temperatures to elevated temperatures that cause metal to glow cherry red.
- Non-corrosive service to corrosive conditions so severe that each piece of material must be tested and evaluated individually.
- Static conditions to ultra-high rotational speeds.
- Dimensions that can be measured with an ordinary rule to those measured with microscopes and other types of optical tooling.

Quality Characteristics

Safety and serviceability of material and equipment are controlled by quality characteristics. These are tabulated at the bottom of page 263.

These quality characteristics, which control the safety and serviceability of chemical-plant material and equipment, do not ordinarily demand complete perfection. Such perfection is extremely difficult to attain and it ignores economic factors.

Rather than shoot for perfection, we aim for a proper economic balance of quality characteristics in our process equipment and machinery so that the plant will be satisfactory economically.

To obtain balanced equipment quality that will satisfy these economic considerations, we define and analyze the controlling quality characteristics. Then we know that design engineer, manufacturer and user will speak the same language

*Meet your author page 331.

STRAIN gages measure test stress on ultra-high-pressure vessel behind barrier.

and have the same concept of the quality required.

This job is done by engineering specialists who prepare *Inspection Briefs* to instruct and guide our field inspectors. All the quality features required in the manufactured items are explained in common terms and language. General terms, such a flat and smooth, are avoided while the critical elements of design are highlighted and emphasized.

When possible, *Inspection Briefs* for complex equipment are reviewed in detail with the production department of the manufacturer prior to placing the purchase order.

Inspection Briefs have proved valuable in reaching the degree of understanding that underlies the balanced quality we have obtained in our process equipment.

Method of Manufacture

Standard or mass-produced equipment, by its very nature, requires that the manufacturer use jigs, fixtures and numerous nondestructive testing methods. Typical of such equipment is the electric motor.

Unless we have had poor service experience, we depend almost entirely on the manufacturer's quality control on such items.

On purchases of process material and equipment, we analyze, define and follow through our quality requirements in direct proportion to the deviation from standard, degree of specialization and uniqueness of the order.

Typical of the type of equipment requiring such maximum attention is a 125-ton column fabricated with ½-in. copper liner. On this type of job we prepare *Inspection Briefs* to detail quality requirements related to method of manufacture and the testing procedures.

Structural Integrity

Foremost among the quality characteristics is structural integrity. Dependent upon it are physical safety, protection of product and the ability to withstand working stresses without fracturing or deforming. Of course, physical safety is the most important factor of all.

Hydrostatic Test—Usually, structural integrity is tested hydrostatically. Pressure-containing equipment is tested in this fashion when it is new and also at intervals throughout its service life.

Hydrostatic tests are applied according to the rules of the ASME Code for Unfired Pressure Vessels. Pressure in the vessel is increased slowly to a point where the stress is 50% greater than the maximum allowable design stress of the weakest element of the vessel.

Vessel is watched carefully for any sign of yielding or indication of failure. Some of the things we look for during the test are:

- Indications of yielding of the flanges.
- Undue distortion in the shell or heads.
- Evidence of cracks in the welds or base metal.
- Leakage at any parts of the vessel.

After the hydrostatic test, it is extremely important to examine carefully the interior of the vessel for any evidence of permanent distortion, cracks or other evidence of failure that may have developed during the test.

On hydrostatic testing of ultra-high pressure vessels, we use strain gages to measure the stresses at various locations as the pressure is increased.

Many people do not realize that you can test an open-top tank hydrostatically merely by filling it with water. Depending upon the depth, the pressure due to the weight of the water column may be greater than pressure applied to a small vessel with a pump.

Failure from water pressure in an open-top tank is a possibility. Recently, an oil storage tank, measuring 140 ft. in dia. by 54 ft. high, burst when filled with water to the 48-ft. mark.

A sister tank on the same site also failed. Failure was caused by cracks which started in the welds.

Radiography — As we all know, radiography detects and records cracks, lack of fusion, lack of weld penetration, porosity, shrinks and other detrimental defects that may be present in weldments, forgings and castings. We specify radiographic examination for an appreciable quantity of our critical equipment.

During the period from 1941 through 1946, we leased a radium capsule and employed qualified technicians for radiographic work in manufacturers' plants and on our plant sites. This capsule was moved about the country and used when the manufacturer did not have radiographic equipment.

However, since World War II radiographic equipment has become quite common. Most manufacturers of equipment have their own source or one that is readily available so that we no longer need to lease a capsule.

At the present time our various suppliers use radium, cobalt 60, cesium, X-ray from 200,000 to 2 million v., and the 15-million-v. Betatron.

The purpose of taking radiographic pictures is to show subsurface defects. In order to get maximum value from this inspection tool we insist that our suppliers use good radiographic techniques.

We require use of fine-grain film, and proper exposure time to obtain a relatively dark film with a shade density of 2 to 2½. Also, we require a film free of water marks, scratches and other confusing defects that can be caused by improper handling and developing.

As radiographic quality standards for weldments and pressure vessels we use the ASME code and for quality of castings the ASTM standard, E71.

We limit interpretation of X-ray to senior inspectors who have had considerable training and experience in the principles of radiography, who are experienced in inspection according to the ASME Unfired Pressure Vessel Code, and who are completely familiar with chemical-plant equipment.

These men know that there is a great deal more to radiographic interpretation than comparing the film against a standard. They study the geometry of the equipment and the radiographic technique being used. Thus they can be sure that those locations most likely to have defects are exposed properly.

In some instances where multiple items of equipment are to be tested, we establish on the first piece the radiographic technique, standards of interpretation and methods for repairing defects.

Ultrasonic Test—We have used ultrasonic testing to detect internal cracks in shafts and other types of forgings. Our most extensive application was in connection with a large amount of equipment in a chemical process which could cause hydrogen blistering. Included were over 100 large bubble-cap columns, numerous heat exchangers and other process vessels.

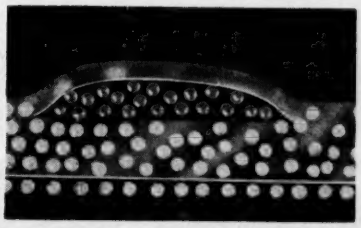
Hydrogen blisters are caused by a particular type of corrosion occurring on the inside wall of a carbon-steel vessel. This corrosion liberates atomic hydrogen.

Atomic hydrogen diffuses through carbon steel at a high rate. During passage through the steel the hydrogen atoms will collect in any voids they happen to hit.

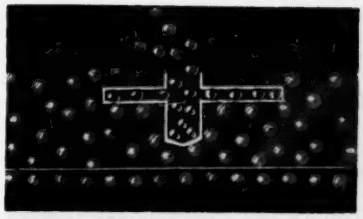
In the voids, the hydrogen atoms combine to form molecular hydrogen. These molecules diffuse at a much lower rate than the atoms.

Since atomic hydrogen keeps diffusing into the voids but very little of the resulting molecular hydrogen leaves, pressure increases within the void to the point where it may blister the plate. Actual measurements have shown these pressures to run as high as 15,000 psi. So you see blistering can cause serious equipment failure.

FAILURE of pipe occurred when hydrogen from internal corrosion blistered wall.



BLISTER forms when hydrogen migrates into lamination making a pressure pocket.



VENT drilled through plate to laminated area prevents accumulation of hydrogen.

Our first approach to the problem was to attempt to procure carbon-steel plate free of voids and lamination. But we found that such plate material was not readily available.

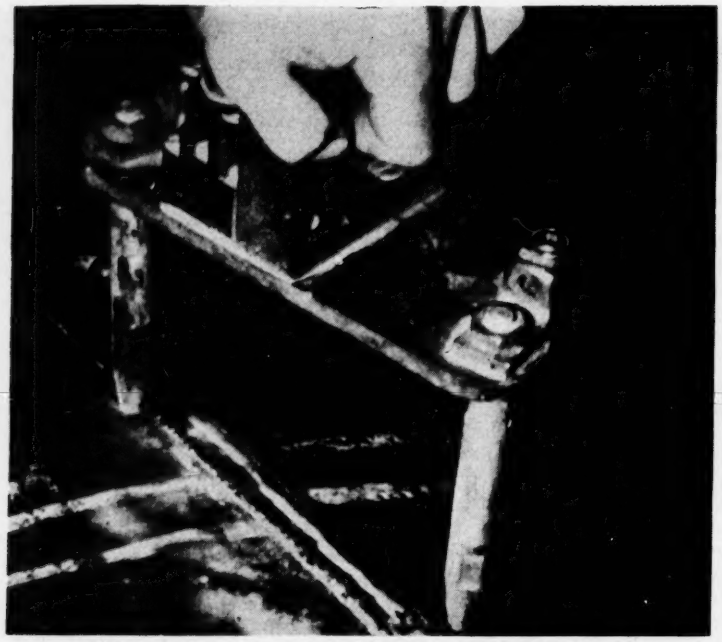
We decided, therefore, to use ASTM A-212 plate material and to examine each plate ultrasonically to locate laminated areas. These areas then could be vented to the atmosphere to prohibit buildup of pressure.

Each plate was scanned ultrasonically on 3-in. centers using a 1-in. crystal at 2¼ megacycles. When voids or laminations were discovered, the area was searched with the crystal. Then, the laminated area was outlined and marked permanently with paint.

Inspection Is Based on Quality Characteristics*

Quality Characteristic	Inspection Technique
Surface finish	Hydrostatic, radiographic, ultrasonic, magnetic, fluid penetrant, polarized light.
Use materials as specified	Huey test, oxalic-acid test, molybdenum spot test, ultrasonic.
Leak tightness	Hydrostatic, air and soap bubble, halide, ammonia, mass spectrometer, spark.
Dimensional tolerances and stability	Gages, strain gages.
Surface cleanliness	Ferroxyl test, white-cloth, spectrometer.
Surface finish	Visual comparison with standards, surface analyzer, optical slit microscope, multiple-beam interferometer.

*Mass-produced items—generally inspected by manufacturer; custom-built units—inspected by user.



MAGNETIC particle inspection indicates crack in longitudinal weld.

FLUID penetrant uncovers crack.

We found that laminated areas less than 4 sq. in. were not detrimental. Areas larger than 4 sq. in. up to 200 sq. in. were vented; areas more than 200 sq. in. were rejected.

Laminated areas were vented by drilling one ¼-in. hole for each 50 sq. in. Holes were positioned to be outside after fabrication and extended three fourths of the distance through the plate.

Many hundreds of plates and heads were scanned, ranging in gages from ⅜ to 1⅞ in. in sizes up to 9 ft. wide and 37 ft. long. Out of this total, approximately 108 plates required venting, 91 were rejected as not suitable for the service and the balance was used. Equipment fabricated from this material now has been operating without failure for several years.

Magnetic, Penetrant Systems— The magnetic and fluid penetrant systems are additional important nondestructive test methods for insuring structural integrity. Frequently, we use these methods to detect cracks and surface defects which are not readily visible.

Magnetic particle testing utilizes the principle that discontinuities in magnetized metal cause irregular flux patterns which may be outlined by magnetic particles applied to the surface.

This method has the advantage that it can be applied without elaborate preparation of the surface in most cases. By necessity, it is applicable only to magnetic material and requires special equipment.

We use magnetic particle indication to reveal cracks in longitudinal welds of pressure vessels. Also, we use this procedure to inspect nozzle welds and other fillet welds of otherwise fully X-rayed pressure vessels. That is because X-rays of such welds cannot be interpreted satisfactorily.

The ASME Code makes magnetic particle inspection mandatory for the inspection of boiler-drum welds when the welds are drilled for tube holes. It supplements the X-ray requirement for such welds as a means of detecting defects that do not show up on X-rays.

Fluid-penetrant inspection is performed by applying an oil-base penetrant to the surface of the object to be examined. When the surface oil is removed and a developer applied, surface defects are indicated clearly either by the contrasting color of the penetrant in the developer or by its fluorescence under an ultraviolet light.

Cracks in longitudinal and girth welds of vessels can be detected by this method. We use it many times every day because it is effective, inexpensive and easy.

The fluid-penetrant method is recognized by the ASME Unfired Pressure Vessel Code and is mandatory for the inspection of all welds in austenitic stainless-steel vessels over ¾ in. thick, regardless of whether or not the welds have been X-rayed. At the present time we are examining, with fluid penetrant, the welds of 50 stainless-steel pressure vessels which have been operating continuously for several years.

Polarized Light — As a nondestructive test for structural integrity, polarized light also is used. We use polarized light to measure stress in plate-glass structures such as operational viewing windows.

On a typical setup to determine the stress pattern in a glass plate we used a photo-flood bulb as a light source. In front of the bulb a piece of frosted glass diffused the light. Then a piece of polaroid glass was placed on either side of the glass plate being checked.

The glass was checked at its point of manufacture before it was mounted into its steel frame and again after mounting. Finally, it was checked for residual stresses after it was installed at our plant site. One such large viewing win-

dow was found to have maximum stress of approximately 3,000 psi. This was considered unacceptable and the glass was removed from the steel frame and remounted.

Use of Specified Materials

Functional quality of process equipment may be influenced considerably by any deviation from specified physical properties, chemical composition and corrosion resistance of the materials used for fabrication.

For example, on a stainless-steel distillation column slated for severe corrosion service the user must be certain that each piece of stainless steel in the column will have required corrosion resistance. On the other hand the chemical properties of materials actually used in a cast-iron pump probably are not too important to the functioning of the pump.

When stainless steel is not used properly, materials in process may attack it preferentially at the heat-affected zones on either side of welds. Such attack can be prevented by using a different type stainless steel or by solution heat treatment after welding.

Huey Test — Many years ago W. R. Huey of the Du Pont Co. evolved a test to control the quality of stainless steel. In this test, samples of stainless steel are boiled in nitric acid for 240 hr. Loss in weight is a measure of the amount of corrosion.

This test is now used widely and is known as the Huey test, or boiling nitric acid test. We have controlled the quality of thousands of tons of stainless steel by this method.

Oxalic Etch Test—A newer test for the more commonly used grades of stainless steel has been devised by Dr. M. A. Streicher of the Du Pont Engineering Research Laboratory. Called the Oxalic Acid Etch Test, it performs the same quality control function as the Huey test and does it in a matter of minutes. Since it may be made directly on the actual piece of material, it is truly a nondestructive test.

MOLYBDENUM is present in stainless steel when spot turns pink.

In the accompanying illustration we show how a satisfactory piece of stainless steel looks at 500 magnification. The step structure is produced by the etching which attacks some grains more severely than others. There is no preferential etching of the grain boundary.

Accelerated etching around some of the grain boundaries, which indicates unacceptable metal, is also shown. Most of the boundaries actually are surrounded by ditches which makes this known as ditch structure.

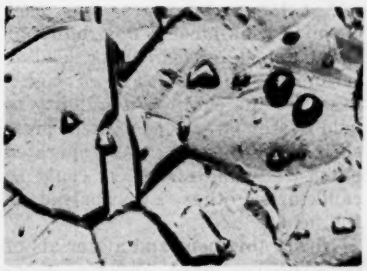
Accelerated etching at the grain boundaries is due to carbide precipitation which usually results from improper heat treatment. The oxalic test may be considered a screening test. Material rejected by this test may prove satisfactory by the boiling nitric acid test, but not vice versa.

Molybdenum Spot Test — For some chemical processes, it is necessary to add molybdenum to stainless steel to improve corrosion resistance. When this element is specified, we supplement the Huey and oxalic tests with a spot test for molybdenum on each piece of material used in the equipment. We do this because we have had a few costly failures which, on analysis, were attributed to lack of molybdenum.

The moly spot test is made by placing a small piece of filter paper saturated with 10% nitric acid between an aluminum cathode and the stainless steel to be checked. Application of 4½-v. d.c. for about 30 sec. dissolves some of the stainless steel and carries it into the filter paper.

Paper is then treated with one drop of HCl, one drop of KCNS and one drop of $Na_2S_2O_3$. Presence of molybdenum is indicated by formation of a carmine pink color.

While tedious to apply, this test has weeded out hundreds of pieces of below-spec stainless steel. If such material had been incorporated into our equipment, it possibly could have caused one or more plant shutdowns.



STEP pattern produced by acid etch indicates satisfactory stainless steel.

DITCH pattern etched around grain boundaries shows poor metal quality.

Ultrasonic Test — Ultrasonics have been applied to checking the bond between steel and homogeneously bonded lead. We use this method as standard practice for testing homogeneously leadlined pressure vessels and other equipment.

On one job that we had to check, we used a prototype to set up a test procedure for proving out the bonding of lead to carbon steel and stainless steel. This test indicated such poor bonding to the stainless steel that we changed the actual specifications for the equipment from stainless steel to stainless-clad steel.

Other nondestructive tests that check use of specified materials in the desired manner include Rockwell, Brinell and Scleroscope for hardness of metals; Durometer and Plastometer for hardness of rubber. All of our inspectors carry a pocket magnet to check austenitic stainless steel.

Leak Tightness

Freedom from leaks has gained importance within recent years so that it is defined more rigorously than formerly.

Not too many years ago, most chemical equipment was built of riveted steel, brazed copper, lead or ceramics. The standard of tightness was the equipment's ability to hold water at a designated pressure. Equipment was operated batch-wise, and any leaks could be caulked or otherwise repaired in the field.

Now, equipment and materials of construction have become more complex to satisfy the needs of modern chemistry and to have dependability built-in for continuous process operation. So, it has been necessary to establish new standards of leak tightness.

The hydrostatic test and the air and soap-bubble test are still used most frequently to locate leaks in chemical equipment. But they have been supplemented with more critical test procedures.

Halide Test—We use the halide test with considerable regularity to check for leaks in pressure equipment and systems.

Test consists of introducing Freon or another halide into the vessel or system on a weight per volume basis. Then the pressure of the system is boosted to the required test pressure with compressed air or nitrogen. All welds and mechanical joints are probed for leaks with a G. E. halide leak detector.

In conducting this test, it is important to make certain that the equipment has been dried thoroughly beforehand. Otherwise, water will lodge in small cracks or other openings and prevent the Freon from permeating through possible defects.

Ammonia Tests—A disadvantage of this test is that halides normally present in some industrial atmospheres make the test unworkable. Under such conditions, we use the ammonia phenolphthalein test.

The equipment is pressurized with a mixture of air and ammonia and the weld painted with a mixture of phenolphthalein, glycerine and titanium dioxide. A pink color indicates a leak.

Mass Spectrometer — On high-vacuum equipment, we test leak tightness with a mass spectrometer. Equipment under test is blanketed with helium. The vacuum space then is analyzed with the mass spectrometer to detect traces of helium. One part of helium can be detected in one million parts of air which is equivalent to a leak of one cubic foot in 90,000 years.

Spark Tests — Leaks in rubber linings are detected with a spark test. The same technique is used also for testing glass coatings.

Dimensional Tolerance

We use many types of measuring devices including optical tooling to check dimensional tolerances of parts and assemblies. In some cases optical tooling is incorporated permanently into the equipment to measure distortion in operation.

In one case, a roll measuring 60 in. dia. by 120 in. long was designed to extremely close tolerances on diameter and runout. Repeated dimensional checks indicated a lack of dimensional stability. Strain gages mounted in the ribs and end sections showed us that additional stiffening was needed in this area.

To overcome this deficiency we welded a solid steel disk over the ribs. This extra metal increased the stiffness of the end plates so that tolerances were maintained.

Surface Cleanliness

Perhaps this requirement is not considered often as applied to chemical process equipment. But it is especially important to the manufacture of synthetic fibers, plastics and atomic energy work.

Since cleanliness may vary from broom clean to almost surgically clean, this factor must be controlled during manufacture of the equipment to satisfy requirements of the end product to be produced in the equipment.

Ferroxyl Tests—One of the cleanliness problems encountered most frequently is to eliminate free iron completely from the surface of stainless steel, nickel and aluminum. To check this condition we use the Ferroxyl test.

A solution of $K_3Fe(CN)_6$, HNO_3 and distilled water is sprayed or swabbed on the metal surface. If the solution turns blue immediately, free iron is present. Usually, this free iron is removed by pickling, grinding or scraping and the test repeated.

White-Cloth Test—For plain, ordinary surface dirt we use the white-cloth test which is similar to the white-glove test used by the Army. It is a test which is difficult to pass.

As its name implies, this test consists merely of rubbing the metal surface with a white cloth. If the cloth remains clean, the equipment is acceptable. If any soil is picked up by the cloth, the equipment must be recleaned and the test repeated.

On one variation of this test, we blew white cloth pellets through 658,000, 30-ft. pieces of stainless-steel tubing to prove that the tubes were clean inside.

Spectrometer—A third way we test cleanliness is to rinse the surface under test with carbon tetrachloride. The solvent is examined with a spectrophotometer to detect dissolved hydrocarbons.

Surface Finish

Most chemical process equipment is made from plate, sheet, casting, bar and forging. As supplied, the mill finish on these shapes usually is a satisfactory working finish.

However, some equipment must be polished to control the quality of the finish. Most frequently the material is stainless steel. We usually have a sample prepared by the manufacturer for each job. Acceptance of the completed work is based on visual and fingernail comparison with the sample.

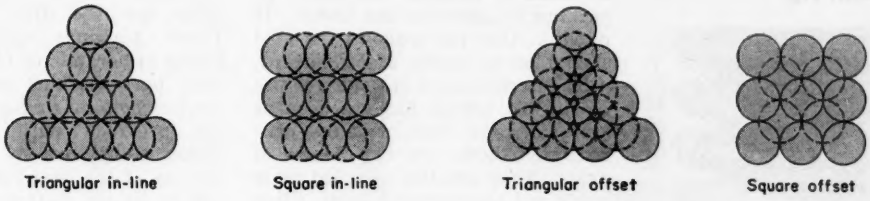
Machine finishes include grinding, honing and lapping. These are measured in microinches by determining the average variation between the peaks and valleys on a surface. Values are designated as root mean square averages (RMS) or as arithmetical averages (AA).

The RMS values for different types of machine work are represented by standard samples available from General Electric Co. On the rougher finishes, the inspected part and standard are compared visually and with fingernail.

For finishes finer than 32 RMS, we usually check with a stylus-type surface analyzer. The newer ASA roughness standard, using arithmetical averages, approximates the RMS values so closely that we use them interchangeably.

For the occasional finish that must be below 4 micro-in., optical methods generally are used. Among these are the optical slit microscope and the multiple-beam interferometer.

This article is adapted from author's presentation at 16th Annual Convention of the Society for Nondestructive Testing, Cleveland, Ohio, October 9, 1956.



Arrangement, Installation and Packing Performance During . . .

Gas-Liquid Flow in Stacked Towers

Handle large volumes of gas at high liquid rates; even when fluid streams carry entrained or suspended solids. Also how liquid distributors influence flow characteristics in stacked packings.

MAX LEVA, Consulting Chemical Engineer, Pittsburgh, Pa.*

The preceding two articles have dealt with gas-liquid flow in towers that carry dumped packings. In the present article the discussion of gas-liquid contacting is continued. As far as contacting device is concerned only packings pertaining to towers are discussed.

Broadly speaking a stacked tower comprises a shell which houses a packing, arranged in a regular geometrical pattern. From the latter requirement it is apparent that packings used in stacked arrangements must be of relatively simple shapes. This is necessary so that they will lend themselves readily to the formation of a stable packed structure.

There are three major reasons why in certain contacting operations a stacked tower may be called for. As far as gas flow is concerned, the most essential difference between the dumped-bed and the stacked-bed tower is the greatly reduced flow resistance offered by the latter. Hence stacked-bed towers are usually considered where very large gas quantities are to be handled.

Also, they are used where gas pumping costs would become excessive or column diameters unreasonable if dumped beds were employed. Another characteristic of stacked packings is their ability to handle large liquid rates. Thus one is likely to encounter stacked beds where the solubility of the component to be removed from the gas is low. Therefore high liquid to gas rates are required.

Finally, the use of stacked beds may be necessary where the gas or liquid carries entrained or suspended solids. The regular arrangement of stacked beds prevents solid deposits from building up as readily on the packing surface than in dumped beds.

Packings

There are essentially two types of packings that lend themselves to stacking. They comprise the ring shapes and grids. A brief survey of features of the more frequently used rings is given in the table. The plain ring is identical to the Raschig ring. Material permitting, the ring is extruded. This method of manufacture, using the plastic-flow properties of a high-solids suspension of particles in water, gives considerably higher material densities than dry-pressing. The extra strength gained is greatly desired because in a stacked tower the lowest packing strata are under considerable compressive forces.

In this respect the stacked-bed situation is quite different than in the random-packed tower. In the latter, and especially with saddles, the bottom portion of the packing is under a considerably smaller compressive load. This occurs because much of the weight of the random-packed column is directed toward the walls of the tower.

Permissible loading in stacked towers is affected by the strength of the packing material. Generally, the material is strong enough to support up to 60 feet of packing. In most cases this is sufficient so that in industrial towers no intermediate supports will be required.

Rings may be stacked of course in a great number of ways. However, the two most frequently employed patterns are shown in the illustration. As for vertical arrangement, the strata are always

How the Series Is Organized

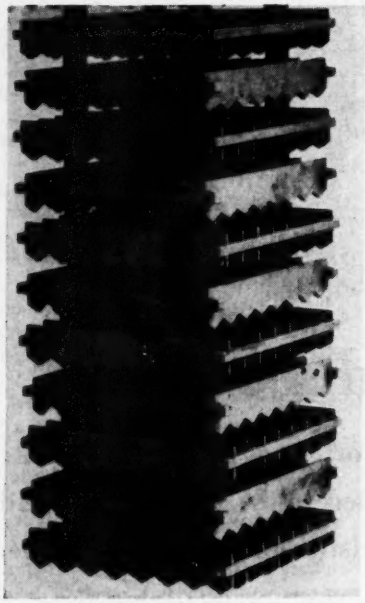
Random packed towers
- Gas-liquid systems
- Liquid-liquid systems

Stacked towers
- Gas-liquid systems

Reactors
- Fixed bed
- Moving bed
- Fluidized bed

*For author biography see *Chem. Eng.* Jan. 1957, p. 294.

Paragrid Tower, Fig. 1



Powell Duffryn, Ltd., England, Manufacturer

offset in order to provide the maximum stability and to minimize chimney-action in the tower.

Material permitting, Lessing rings and cross-partition rings are just as readily extruded as plain Raschig rings. The additional internal structural features of these rings permits them to stand up under high compressive loads. Also in the stacked arrangement, the internal surface is readily available for gas-liquid contacting. For this reason these special rings offer definite advantages over the use of plain rings in stacked towers.

The more complicated spiral rings are also extruded. The operation takes place in two or more steps. The outside ring is extruded first and then the spiral is extruded into the center. The use of the inside spiral arrangement causes fluid turbulence as well as providing additional contacting surface.

From pressure drop, absorption capacity data and comparison with the simpler partition ring, it must be concluded that the inside surface of the spiral ring is unavailable due to by-passing of the fluids. This is to be expected because of the relatively high flow resistance which the interiors of these packings offer to the passage of fluids.

Usually a simple grid structure of metal or ceramic will suffice as packing support in the tower. If possible, the free space in the grid should be in excess of 50 percent.

The development of grids for use in stacked towers has not been as systematic as that of rings. Essentially there are two kinds of grids. They are the so-called plain grids and the serrated grids. Plain grids are horizontal wooden bars placed in parallel. Individual decks are then set on top of one another so that bars of adjacent decks are at right angles to each other. Decks may be offset at regular intervals to eliminate chimney effects.

The width and depth of the bars and the distance between them primarily determines flow resistance. However, these factors do not necessarily influence mass transfer. The latter is dependent on mode and rate of irrigation, material of construction and workmanship associated with tower construction.

If individual adjoining decks of grids are not in mutual contact along the vertical tower dimension, it is desirable to provide the lower edge of the grids with serrations. Obviously, this will be required to facilitate a more effective liquid distribution over such a structure. Again, construction details of serrated grids have not been rigorously standardized.

In recent years a new grid, the so-called Paragrid has been developed. This structure employes serrated members arranged in decks as shown in Fig. 1. It is made of a special kind of carbon with surface texture such that liquids will tend to spread and to descend in the form of thin films.

Related to the serrated-type grids are the drip point grids. These packings are essentially blocks of ceramic or other material that have parallel vertical slots. At the bottom surface, the blocks are provided with drip points. These points are in contact with the top of the next lower block and aid in liquor distribution.

With blocks and most grids, it is not easy to use round-shell towers. Square towers, though not a great inconvenience in atmospheric or low pressure operation, may become an expensive item when required to withstand substantial pressures.

Flow Over Stacked Packings

In dumped-bed towers reliance can sometimes be placed on the packing to act as its own liquid distributor. In general this may not be desirable. The use of too few distributor points in dumped-bed towers may at its worst lead to a loss that is equivalent to a few feet of packing. However, in stacked towers too few distributor points will almost always render the entire tower virtually inactive. Stacked packings cannot distribute liquids laterally to any appreciable extent.

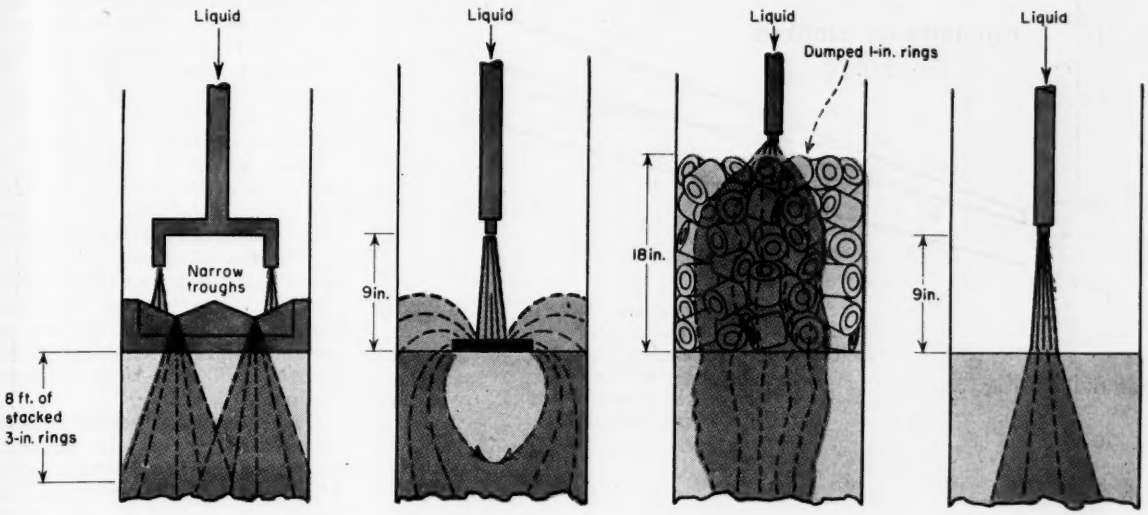
With grids each member must be fed individually. This is accomplished either by the use of specially designed over-flow weir systems or by a network of centrally fed perforated pipes. The number of outlets will be dependent on the irrigation rate.

With rings, liquid supply to each individual element is impractical.

Characteristics of Stacked Packings

Kind	Nominal Size Range	Material of Construction	Special Features
Plain rings	3 in. or larger	Chemical stoneware, porcelain, carbon, metals	Outside ring diameter equals ring height.
Lessing rings	Up to 6 in.	Ceramics, metals and carbon	Outside ring diameter equals ring height Element carries a central partition, thus providing two central cells.
Cross partition rings	3 to 6 in. (or longer)	Ceramics	A Raschig ring, carrying a cross partition inside, thus yielding four central cells.
Spiral-type rings	3 to 6 in. (or longer)	Ceramics	A ring carrying internal centrally located spiral paths. Depending on number of paths, rings are known as single, double or triple spiral rings.

Compare Relative Efficiencies of Liquid Distribution Methods, Fig. 2



For this reason splash-type or spray-type liquid distributors are frequently recommended. Care must be taken that the liquid is not thrown initially to the wall. Otherwise, it will continue to run down the wall and lead to poor efficiency. The importance of initial liquid distribution in stacked towers has been generally appreciated. Enlightening data to this effect are given by Pratt[8]. Operating with a square tower of 18 in. on edge and stacked with three inch rings, he employed several types of irrigation and noted mass transfer performance.

Three typical modes of distribution are indicated in Fig. 2. The relative performance varies about six-fold when distribution from the single direct stream was modified so as to emanate from the trough-type distributor. By introducing the splash disc, performance improved nearly five-fold. This is significant and emphasizes the good performance of this often convenient type of distributor.

A layer of dumped-packing on top of the stacked-bed is another method for distributing the liquid stream. This requires that the dumped pieces must be large enough so that they will not fall between the free spaces in the stacked bed. To achieve random distribution, a relatively large packing element may then be required.

Since large pieces even if dumped are not particularly efficient liquid distributors, a graded bed of random-packing may be required. Although the dumped packing may physically work satisfactorily, there may be many objections to its use. One obvious drawback is the limitation on throughput which such an arrangement will impose on the tower.

In the ideal case, film flow is approached in stacked beds. Therefore, the stacked tower is in a sense a modified wetted wall tower. As in the latter, definite liquid rates are required to cover the entire available surface. This rate is known as the minimum wetting rate. Systematic investigations as to the minimum wetting rate are still lacking. As the minimum wetting rate is surpassed the laminar fluid film becomes turbulent. This is evident by the advent of ripples in the liquid surface .

At still higher irrigation rates the liquid tends to break away from the packing surface. This is known as cascading-flow. Generally, it has been observed that a stacked packing will operate most efficiently just before the flow becomes cascading. This is true because the resulting surface renewals and fluid mixing prior to cascading further mass transfer.

Cascading on the other hand is a flow disturbance that will lead to non-uniform conditions of concentration in various tower cross-sections. Thus cascading will tend to lessen the driving force in the tower, and thereby the rate of mass transfer.

In the absence of cascading-flow, stacked-beds give rise to smaller liquid carry-over losses than dumped-beds operating under the same superficial gas and liquid velocities. This is so because stacked-beds offer considerably more free space than dumped-beds. As a consequence local gas velocities, for given mass rates of flow, are lower in the stacked tower.

Horizontal velocity components of liquid flow are not present in stacked-beds. Consequently, maldistribution of liquids in stacked-beds is not found to the same extent as in dumped-beds. Nevertheless distribution deteriorations are possible to some extent. These phenomena manifest themselves primarily in the form of coalescence of liquid streams. These abnormalities are not ordinarily

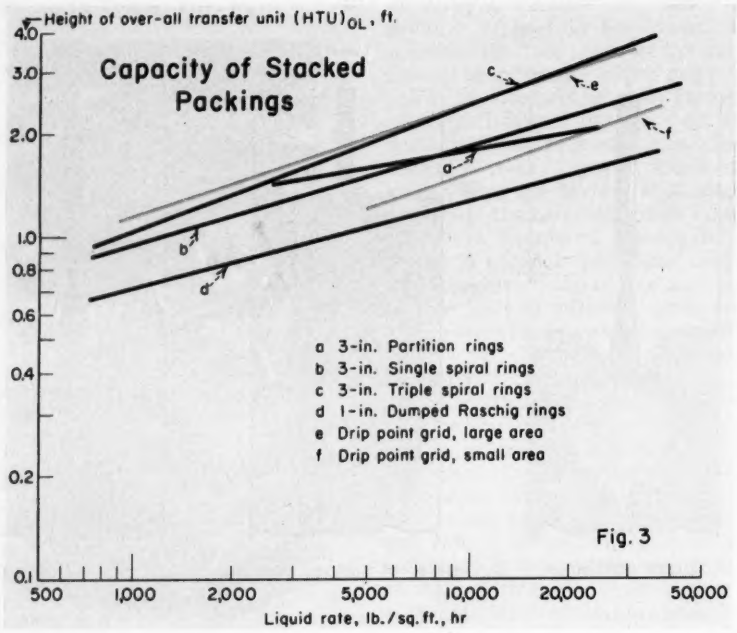

Height of over-all transfer unit $(HTU)_{OL}$, ft.
Capacity of Stacked Packings
a 3-in. Partition rings
b 3-in. Single spiral rings
c 3-in. Triple spiral rings
d 1-in. Dumped Raschig rings
e Drip point grid, large area
f Drip point grid, small area
Liquid rate, lb./sq. ft., hr

Fig. 3

sufficiently severe to require redistribution of the liquid. There is little or no tendency toward wall flow in stacked beds.

No data are available on liquid holdup in stacked-beds. As with dumped-beds, gas flow should have no effect on holdup below loading. Of course in the loading and flooding zone, liquid holdup will increase. This may be deduced from the pressure drop characteristics of the stacked-beds which will be discussed later.

Capacity Data

Few published capacity data are available for stacked packings. Some of these are given in Fig. 3. As expected the data cover systems such as absorption of oxygen and carbon dioxide by water. These systems are instances of low gas solubility and high liquid rates. Values for $(HTU)_{OL}$ are given in relation to liquid rates. The latter extend up to about 30,000 lb./sq.ft.,hr.

It is interesting to observe that the relatively simple partition rings give the most favorable capacity data. In this case their simple construction facilitates ready gas-liquid contact. On the other hand, the spiral rings representing the most complex packing referred to in Fig. 3 give the least favorable $(HTU)_{OL}$ values.

For comparison, data are also shown for 1-in. dumped Raschig rings. Sufficient information is available to estimate capacity data for this packing[4] for almost any set of conditions. Roughly speaking the $(HTU)_{OL}$ for the stacked packings is about 50 percent higher than for the 1-in. Raschig rings. This relation may be used in a broad sense to arrive at the approximate capacity data of well-irrigated stacked packings.

These relative capacity data are interesting if compared to the total surface area provided by the drip point grids. Molstad et al.[1] reported the following values:

Packing No.	Surface Area, $Ft.^2/Ft.^3$	Free Area, %	Wettable Area, $Ft.^2/Ft.^3$
6146	18	41	7.5
6295	24	43.5	10.5
6897	34	42	14.5

In a bed of 1-in. Raschig rings, the theoretical wettable area is much greater than the values indicated in the fourth column.

For the stacked grids shown in Fig. 3, the relatively favorable values of $(HTU)_{OL}$ indicates that these elements are more effectively wetted than random-packed rings. This more favorable wetting ability seems to be a general characteristic of nearly all stacked packings. Additional capacity data for the systems, water-air and water-ammonia, when using a Paragrid tower are reported by Norman.[2]

Other means of arriving at capacity data for stacked packings are presented elsewhere.[3] A possibility not yet considered in detail may be the estimation of stacked-bed capacity data from wetted wall columns. When using this procedure, the frequent surface renewals in staggered stacked-beds probably will give very conservative data.

Over-all capacity coefficient, K_Ga, values were obtained for ammonia absorption using drip-point grids. These packings were stacked in continuous, crossed flue and checkered build-up arrangements. There was virtually no difference in absorption coefficients between continuous and cross flue arrangements. The data pertaining to the checkered arrangement were decidedly lower. It is to be expected with this arrangement because the tower contains fewer packing elements.

Tests were also conducted for the purpose of demonstrating the effect of the lengths of the trip points on the bottom of the packing elements. Their effect was less conclusive and appeared to depend on the gas rate in the tower.

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Next Month

In the next article, Max Leva presents the quantitative flow relations for stacked packings. Included in his discussion are the flow characteristics of rings, grids and drip point tiles.

The author discusses all available information on pressure drop, loading and flooding for the packings. A number of solved problems illustrates the use of the empirical relations.

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Piping

Use this list to help solve your piping problems. The author has compiled from his experience, the references which are most useful in practical design work.

Fluid Flow

Liquids

"Turbulent Two-Phase Flow," J. M. Chenoweth and M. W. Martin, *Pet. Refiner*, Oct. 1955, pp. 151-155.
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"Fluid Flow Losses Through Orifices," Nils M. Sverdrup, *Prod. Eng.*, May 1952, p. 237.
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A single chart for any fluid whose density and viscosity are known. Chart can be used to size pipe for a given rate of flow and pressure drop; or to determine the pressure drop for a given pipe size and rate of flow; applicable to turbulent flow only. Viscosity data given for a number of liquids, gases and vapors for a range of temperatures; graphical form.

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"Analysis of Data on Flow of Steam in Pipes," Robert H. Page and S. Konzo, *Heat. & Ventilating*, Aug. 1951, pp. 86-104.
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Part I—Nov. 1948, pp. 76-77.
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Part II—Feb. 1949, pp. 82-84.
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"How to Layout Steam Transmission Piping, Parts I & II," *Mill & Factory*, Nov. and Dec. 1950.
Part I—Nov. 1950, pp. 113-117.
Pipe size; heat losses; steam velocity; wall thickness computation forms; critical outlet pressures; heat loss computation forms; allowable stresses.
Part II—Dec. 1950, pp. 99-104.
Expansion; graphical solutions for expansion; U-bends; double offset bends; anchor reactions, graphically; welded elbows; economics of piping arrangements; condensate removal; comparative costs.

"Selecting Pipe Schedules Quickly," M. W. Larinoff, *Power*, July 1949, p. 138.
Alignment chart to solve for economic schedule for branch pipe lines off steam headers.

"Bursting and Operating Pressures of Pipe," Industrial Training Institute, *Power Generation*, Jan. 1948, p. 90.
Tabulation based on Barlow's formula.

"Pressure-Temperature Ratings of Plain End Pipe Used in Power Plant Piping Systems," *Pipe Fabrication Institute, Technical Bull.* TBI-1953.
Tabulated arrangement of pressure temperature ratings of carbon steel and alloy steel pipe.

"How to Use Schedule Numbers in Power Piping Design," Sabin Crocker, *Taylor Forge & Pipe Works—Bull.* 515*A*, 1951.
Schedule numbers explained. Charts for selection of pipe wall thickness, relating pipe size and schedule to P/S values.

Aluminum Pipe

"Aluminum Piping's Applications," E. T. Wanderer, *Heat. Piping & Air Cond.*, Nov. 1953, pp. 116-119.
Water supply piping; pneumatic control systems; aluminum pipe and tube properties, tabular form, composition of different grades of aluminum pipe.

"Aluminum Piping, How to Use It," C. B. McLaughlin, *Heat. Piping & Air Cond.*, Apr. 1948, pp. 78-82.
Various alloys and their applications; comparative costs with other piping materials; physical properties and composition of aluminum alloys used in pipe, table of allowable working pressures; fabrication techniques; availability of fittings referred to pipe diameter; cast aluminum; aluminum welding.

"Aluminum Pipe and Fittings," Aluminum Co. of America, *Bull. A*755.30, 1955.
Applications; corrosion resistance; installation; dimensions and weights; collapsing pressures; physical properties; dimensional tolerances; bursting pressures at normal and elevated temperatures; safe loads; support spacing; loss of head for flow of water in aluminum pipes.

Copper Pipe and Tube

"Dimensional and Capacity Data—Copper Drainage Tube," *Air Cond. Heat. & Vent.*, Jan. 1956, Reference data sheet.
Tabular arrangement.

"Anaconda Copper Tube and Pipe," American Brass Co., *Publ. B-1*, AIA File No. 29 b-4. 1953.
Corrosion resistance, physical dimensions, bursting pressures, heat carrying capacities of copper tubes; underground installations; solder fittings; flared fittings; assembly and installation; maintenance; specifications; flow of water and friction loss.

Non-Metallic Pipe

"How to Install PVC Plastic Pipe," *Heat., Piping & Air Cond.*, Dec. 1955, pp. 112-114.
Supporting of pipe; underground installations; solvent cementing; threading; welding; limit bending.

"How to Design PVC Plastic Pipe Lines Economically," *Heat., Piping & Air Cond.*, Dec. 1955, pp. 114-116.
Head loss vs. flow rate; maximum operating pressures for regular and high impact pipe.

"PVC Pipe Fittings and Flanges," Tube Turns Plastics, Inc., 1955.
Applications, corrosion resistance; price comparisons; physical properties; dimensions; operating pressures; support spacing; flow vs. pressure loss.

"National Plastic Pipe—PVC," National Tube Division—U. S. Steel Corp., *Bulletin* 24, 1955.
Physical dimensions and properties; chemical resistance; maximum operating pressures; head loss vs. flow rate; installation procedures.

"National Plastic Pipe—Polyethylene," National Tube Division U. S. Steel Corp.—*Bull. No.* 29, 1955.
Physical properties and dimensions, chemical resistance; maximum operating pressures; head loss vs. flow rate; installation procedures.

"J. M. Transite Pressure Pipe with Simplex Coupling," Johns Manville *BMT-5B4-4Bq*-1954.
Description of materials; installation; operation; capacity curve; annual horsepower; maintenance; dimensions and weights.

"Pipe Lines to the Future," Monsanto Chemical Co., *Monsanto Business Executive Series No.* 3, Dec. 1955.
Types of plastic pipe; mechanical properties; installed pipe and fittings costs (comparative); wall thickness effects; chemical resistance; comparative prices; applications; fabrication methods.

Valves, Special Fittings and Traps

Steam Traps

"For Top Output, Size Steam Traps Right," John W. Welker, *Power*, Jan. 1955, pp. 85-87ff.
Condensate loads; load types; load calculations; submerged surfaces; heating air; trap sizing; table of specific heats; ranges of overall coefficients of heat transfer, radiation from bare iron and steel heating surfaces; installation.

"Steam Trapping," Kenneth G. Oliver, *Instr. & Automation*, March 1954, pp. 470-473.
Selection of proper trap; trap types; selection chart by operational characteristics; trapping of temperature controlled equipment; air removal; steam tracing service.

"Steam Trap Selector," Yarnall Waring Co., *Bull. T-1750*, 1954.
Selection chart by application; capacity sizing; installation.

"Armstrong Steam Trap Book," Armstrong Machine Works, 1946.
Excellent brochure on steam trapping; installation details; application; sizing; venting; trap types discussed; separator service; steam main drainage; unit heaters and air conditioning service, steam kettles; jackets; piping layouts; maintenance.

Relief Valves

"Develop Rules for Installing Relief Valves," *Heat., Piping & Air Cond.*, April 1951, pp. 124-127.
ASME code; officially rated valves; auxiliary relief devices; discharge manifolds; gross nozzle output; protecting vessels on the low pressure side of relief valves.

"Sizing Safety and Relief Valves for Vapor Lines," C. G. Weber, *Chem. Processing*, Sept. 1955, pp. 76-78.
Nomographic form of API-ASME code formula for sizing safety valves.

"Sizing Relief-Valve Discharge Systems," Farris Engineering Corp., *Bulletin FE-182*, 1952.
Discharge quantities; critical back pressure; maximum allowable back pressure; valve sizing; examples.

"Selection and Sizing Pressure Relief Valves to Comply with ASME Boiler Code Requirements," McDonnell & Miller, Inc., 1953.
Presentation of data as applicable to boilers and water heaters. Cast iron boilers; steel boilers; nonrated boilers; sectional rectangular boilers; hot water heaters and supply tanks; heat exchangers or converters; valve selection; unfired pressure vessels.

Valves

"Valves to Combat Corrosion," Cooper Alloy Corp., Sept. 1954.
Materials of construction; valve operation; fabricating procedure affects valve quality.

"Crane Company Adds to Line of Packless Diaphragm Valves," J. Trefil, *Valve World*, No. 3, 1953.
Selection data for diaphragm valves for use with various chemicals and process streams, tabular form; tables show body, disk and diaphragm materials; service suggestions.

Fabrication & Installation

Specifications and Selection

"Dimensional and Capacity Data," *Air Cond., Heating & Vent.*, Apr. 1956, Data Sheet.
Tabular form, for schedule 80 and schedule 40 pipe.

"Stainless Steel Engineering Data," Cooper Alloy Corp., *Catalog No.* 55, 1955.
Physical dimensions of flanges and pipe; pressure temperature ratings; alloy designations, and physical and mechanical properties of cast stainless steel; chemical resistance chart; resistance of valves & fittings to flow; metal casting factors.

"Fabrication and Working Data for Carpenter Stainless Steel Tubing and Pipe," The Carpenter Steel Co., *TD-114*, 1954.
Fabrication and working data; designing for economical fabrication; methods of joining; welding; annealing; finishing; cutting; threading; grinding; cold bending and coiling data.

"Taylor Forge," Taylor Forge and Pipe Works, June 1953.
Review of changes in code for piping; the basis of the code stress allowances explained; tables of maximum allowable stresses ASME Boiler & Pressure Vessel Code; Code for pressure piping with tables. Understandable and usable.

"Taylor Forge," Taylor Forge and Pipe Works, Nov. 1953.
Review of ASA-B 16.5 1953, steel pipe flanges and flanged fittings; pressure and temperature ratings of flanges; method of rating ferrous alloy steels;

report of Task Force on flexibility ASA code for pressure piping.

Threaded Pipe

"Selection, Maintenance, and Piping Practice in Industrial Plants," R. J. Pinske, *Valve World*, 1954, pp. 6-12.
Factors affecting ultimate cost of piping maintenance; installation for ease of maintenance; annual upkeep; cost of water leaks; cost of air leaks; costs of steam leaks; measurement of piping maintenance; cost of neglected maintenance.

"Threaded Piping; Selection, Application and Upkeep," *Plant. Eng.*, Nov. 1953, pp. 110-113.
Article tells what factors should be considered when selecting threaded piping for your industrial needs. It also discusses connections, fittings, flange joints, pipe supports, special clamps, iron plugs and bushings.

"Stainless 5S Pipe Is Added," *Heat., Piping & Air Cond.*, July 1952, pp. 114-115.
Background of inclusion of Schedule 5S stainless in ASA standards. Table of weights and dimensions of stainless pipe 5S, 10S, 40S and 80S.

"Don't Fear Threading of Stainless," The Cooper Alloy Foundry Co., *Bulletin 3M*, Nov. 1951.
Cause, condition and remedy, presentation on how to overcome poor threads in stainless.

Flanged Joints

"Holding High Pressure Joints," Walter Coopey, *Pet. Refiner*, May 1956, pp. 189-193.
Types of closures; application of each, advantages; relative costs.

"Chart Solutions In Flange Designs," Louis J. Murphy, *Pet. Refiner*, Aug. 1954, pp. 131-134.
Seven charts to speed the computation of flange design; basis of charts; scope of coverage; gasket and bolting calculations; leakage during operation; bolting area; gasket contact width; shape constants.

"Flange Bolting Chart for Large Size Pipes," Hans W. Hamm, *Power*, June 1954, pp. 115.
Nomographic form.

"An Improved Flanged Joint For Rubber Lined Piping," G. W. Hauck, *Valve World*, No. 3, 1953, pp. 66-69.
General discussion of the problems involved in connection of rubber lined piping; screwed flanges; welded flanges.

"How Flanges Work and Why They Leak," Robert G. Blick, *Pet. Refiner*, Jan. 1953, pp. 129-135.
Engineering analysis of this problem; the problem of interaction of pressure and bending at pipe flanges; pressure sealing assemblies; bending moment; incremental bolt load; leakage envelopes; bending of flanged assemblies.

"Piping Data Sheet No. 11—Standardization of Nonmetallic Gaskets For Pipe Flanges," J. S. Cekal, *Valve World*, No. 3, 1953, pp. 89-91.
Presentation of the ASA standard B 16.21—1951 for non-metallic gaskets for pipe flanges; test explains the development and purpose of the standard.

"How To Assemble and Maintain Flanged Piping Joints," *Heat. Piping & Air Cond.*, May 1952, pp. 108-109.
Initial stresses, load stresses; torque required to produce bolt stress, presented in tabular form for bolts of various diameters.

"Metallic Gaskets Given Boost By Oil Industry Development," H. H. Dunkle, *Pet. Refiner*, Nov. 1950, pp. 135-139.
Types and applications; welding neck flanges; avoiding overstress; varying stresses; prevention of leakage; perfect joints.

Welding

"Butt-Welding Ends For Pipe, Valves, Flanges, and Fittings," *Valve World*, No. 3, 1955, pp. 119-123.
Specifications in detail with dimensions given in tabular form; illustrative sketches; welding lip design; machining; tolerances.

"Welding Piping Systems-Fabrication and Maintenance," Jay S. Case, *Plant Eng.*, July 1954, pp. 108-113.
Welding processes; characteristics of butt joints, and socket or lap joint with fillet weld; use of backing rings; correct welding procedures; types of joints; permissible raw materials.

"Fusion Welding of Nickel and High Nickel Alloys," The International Nickel Co., Inc. *Technical Bulletin T-2*, Aug. 1954.
Age hardening alloys; dissimilar metals; joint design; arc welding; gas welding; pickling; pressure welding; shrinkage of welds; stud welding; surface preparation; thermal cuttings.

"How To Control Carbide Precipitation In Welding Stainless Steel," G. E. Linnert and R. M. Larrimore, Armco Steel Corp., reprint from *Materials & Methods*, Nov. 1953.
Methods of avoiding sensitization; welding rate; cooling rate; post annealing; ELC steels; heat input; thickness of base metal; stabilized rod; welding technique.

"How To Weld Carpenter Stainless No. 20Cb," The Carpenter Steel Co.; *TD-118*, 1956.
Composition and weldability of stabilized alloys; recommended procedures; design consideration; design of joints; assembly methods; welding dissimilar materials; welding tubing and pipe; welding clad material; cleaning welds.

"New Flash-Welding Techniques," C. Bruno and G. W. Birdsall, Reynolds Metals Co., Reprint from *Welding Journal*, Nov. 1949.
Presentation of new flash-welding techniques; influence of joint thickness; eliminating heat-treating problem; percussive welding; weld finishing; economics.

"How To Weld Aluminum," Reynolds Metals Co., reprint from *The Iron Age*, June 20, 1946.
A review of modern techniques employed in welding aluminum including gas, carbon arc, metallic arc, atomic hydrogen and resistance welding, as well as brazing and soldering; mechanical properties of sheet aluminum; torch welding data; tensile strength of gas welded aluminum alloys; arc welding data; minimum shear strength of spot weld in aluminum alloys; spot welding faults.

"Anaconda Welding Rods and Procedures," The American Brass Co., *B-13*, 1953.
Standard specifications; braze welding iron and steel; oxyacetylene welding; inert gas welding with copper; carbon arc and metal arc welding with copper; feet of weld per pound of rod; melting points; temperature colors of commonly used metals and alloys.

Miscellaneous

"Designing Relief Lines," R. W. Roberts and D. Cornell, *Pet. Refiner*, July 1955, pp. 141-143.
A method which does not require the basic assumption of ideality. Theory; equations developed; charts: example.

"New Design Method for Vent Lines," C. E. Parish and D. Cornell, *Pet. Refiner*, Feb. 1955, pp. 121-123.
A rigorous method making use of Fanno line and Mollier diagram. Theory, equations developed; charts; example.

"Process Piping," Theodore R. Olive, *Chem. Eng.*, Dec. 1955, pp. 187-210.

Metallic piping components; non-metallic piping components; codes, standards, design and information sources; materials of construction; flexible piping; jointing methods; pre-insulated pipe; special joints; valves.

"Clearance Between Screwed Pipe Fittings," George Jankanskas, *Heat. & Vent.*, Oct. 1952, Reference Data Sheet.
Tabular with some text.

"Piping Materials for Chemical Processes," Carl B. McLaughlin, *Heat. Piping, & Air Cond.*, Oct. 1951, pp. 85-94.
Factors in metal selection; maximum temperatures and pressures; wall thickness; stress, creep and rupture; corrosion; alloys classified; welding costs for alloys; fabrication methods; joining methods; relative costs.

"Condensate Piping for Heating Coils," John J. Blank, *Power*, June 1956, pp. 126-127.
Coil operation; elimination of logging and water hammer; air expulsion; check valves.

"These Piping Systems for Fuel Oil Service Will Save You $," Steve Elonka, *Power*, June 1956, pp. 112-113.
Basic system; duplex system; high pressure system; auxiliary startup system; modified high pressure system; large capacity system.

"Blanking Lines in Six Steps," H. T. Libby, *Pet. Refiner*, Sept. 1953, p. 241.
A method for safely blanking off low pressure, large diameter gas lines. Step wise procedure described.

"The Freezing of Water in Pipes and Vessels," Richard S. Dill, *Heat. & Vent.*, Oct. 1953, pp. 96-101.
Existing data on the thermal properties of water and ice that are involved are presented in a form that permits ready interpretation of the results. Freezing point vs. pressure; stress in pipe walls; temperature and bursting pressure; expansion.

"Water Hammer in Pipe Lines," T. W. Reynolds, *Heat. & Vent.*, July 1952, pp. 83-90.
Basic engineering information presented, and various devices described, that are available for arresting and dissipating the energy transmitted by water hammer. The mathematics of the problem are given.

Piping Identification

"Identification of Piping Systems," National Safety Council, *Safe Practices Pamphlet No. 83*, 1950.
Classification of materials carried in pipes; code; identification methods; legend; color stripes; description of colors.

"Scheme for Identification of Piping Systems," American Society of Mechanical Engineers, *ASA-A13-1928*, Reaffirmed 1947.
A systematic plan employing color and other kinds of marking; fundamental principles; material classification; description of colors for special applications: size and position of stencilled letters.

Pipe Support and Thermal Stress

Piping Support Spacing

"How to Space Pipe Supports," Theodore E. Bridge, *Heat., Piping & Air Cond.*, Oct.-Dec. 1949 and Feb. 1950.
Feb. 1950, pp. 92-96.
The problem of insulated pipe; alignment chart for support spacing; examples worked out in detail.
Dec. 1949, pp. 90-92.
Calculating stresses in bare, empty steel pipe with fixed supports; stresses in empty steel pipe with free supports; combined stresses; Mohr circle of stress.
Nov. 1949, pp. 93-96.
Calculation of combined stress; bending moments; clearances; spring hangers.
Oct. 1949, pp. 93-97.
Criteria for support spacing; alignment charts for calculation; review of stresses and moments involved in pipe support; weights per foot of pipe (tabular form); correction factors for materials other than steel.

Selection and Methods of Supporting

"The Selection of Pipe Supports," E. W. Stothart, *Combustion*, May 1951, pp. 3-7.
Hanger location; anchoring; methods of attachment; sway bracing; vibration dampeners; thermal pipe movement; calculation of hanger loads; maximum spacing; determination of pipe movement; capacities of hot rolled steel rod.

"Use of Welding to Facilitate Piping Suspension and Support," George W. Hauck, *Heat., Piping & Air Cond.*, March 1951, pp. 83-87.
Suspension of piping; support of piping; plate lugs as integral supports; welded base supports.

"Methods of Supporting Pipe," J. E. York, *Heat. & Vent.*, Jan. 1951, pp. 68-70.
Supports for piping in tunnels; special structural supports; two rod roll type hangers; pipe covering protection saddles.

"Pipe Supports and Pipe Restraints," Robert G. Blick, *Pet. Refiner*, Dec. 1949, pp. 128-138.
Application of principles of statics and strength of materials to pipe support. Pumps and compressor piping; expansion joints; tower and drum piping; fired-heater piping and anchors; exchanger piping; yard piping; bowing effect of long runs; pipe size reductions.

"How to Erect High Temperature, High Pressure Piping," Arthur Gould, *Heat., Piping & Air Cond.*, Jan. 1949, pp. 107-110.
Erection problems with welded joints; cold springing; general method of erecting flanged piping; how to correct for discrepancies.

"Supports and Anchors for Piping," Tube Turns, *TT 726*, 1955.
Support and anchorage of piping; anchors; spacing of supports; spacing of supports.

"Practical Piping," Robert C. Soronen, *Heat., Piping & Air Cond.*, Mar. 1950, pp. 104-106.
Anchoring and supporting process piping; guide rods; cantilevered anchors.

Data and Calculations for Hanger Loading

"How to Determine Expansion in Carbon and Alloy Piping," Robert J. Rubey, *Heat., Piping & Air Cond.*, Mar. 1955, pp. 145-146.
A direct reading chart gives the increment of thermal expansion for a given length of pipe at a given operating temperature. Examples worked out.

"Taylor Forge," Taylor Forge and Pipe Works, *Vol. 2-No. 1*, June 1956.
Review of current codes and standards; stresses; tables for allowable stresses—ASME Boiler Code; tables for allowable stresses, ASA code for pressure piping; limiting dimensions of gaskets meeting requirements of ASA B16.5; assembly of steel raised face flanges to flanges of other materials of construction.

"Hanger Load Calculations," Grinnell Company, 1951.
Hanger load calculation method with detailed example and charts. Weight of piping materials, fittings and insulation; (1 to 24 in. diameter); thermal expansion of piping materials.

Piping Flexibility Calculations

"Pipe Flexibilty Calculations," R. G. Blick, *Pet. Refiner*, Feb. 1954, pp. 123-130.

An analysis routine and calculation forms for piping flexibility involving only arithmetic, with no reference to formulas. The method is more compact and requires less training in its use.

"Calculating Flexibility For Straight Line Piping Elements," L. E. Partch, *Heat., Piping & Air Cond.*, Dec. 1953, pp. 74-77.
General concept of elements; single plane elements; use of K values third dimension elements; torsional deflection; secondary bending deflection; determination of force and stress.

"Methods of Making Piping Flexibility Analyses," Sabin Crocker and Arthur McCutchan, *Heat., Piping & Air Cond.*, July 1953, pp. 87-90.
Variation of methods; bibliography of methods; summary of methods; recommendation; three dimensional example by several methods (comparison).

"Methods of Making Piping Flexibility Analyses—The Grapho-Analytical Method," Arthur McCutchan and W. P. Gregory, *Heat., Piping & Air Cond.*, March 1953, pp. 92-97.
Advantages and disadvantages of the method; examples worked out; procedure to be followed; forms illustrated.

"Easy Tables Crack Tough Pipe Problem," S. W. Spielvogel, *Power*, Oct. 1952, pp. 92-93.
Three dimensional 90-degree turns for power and industrial applications.

"Methods of Making Piping Flexibility Analyses," Theodore E. Bridge, *Heat., Piping & Air Cond.*, Oct. 1950, pp. 94-98.
How to design piping with required flexibility; comparison of methods; review of flexibility theory.

"Methods of Making Piping Flexibility Analyses," Theodore E. Bridge, *Heat., Piping & Air Cond.*, Sept. 1948, pp. 78-82.
Advantages of column analogy method; development of equations; planer two anchored pipe bend; limitation of analogies; multiple plane pipe bends; effect of pre-strain.

"Design of Piping for Flexibility with Flex-Anal Charts," Blaw-Knox Co., *Catalogue No. 2482*, 1954.
Complete design method for piping flexibility calculations with charts required for use. Forces, moments and stresses; U-bends, quarter bends; stresses where pipe sizes change; effect of radius and minimum height; U-bend in two planes; Z-bends; application of the Flex-Anal Charts; anchors; guides; vibration eliminators.

Stress and Deflection

"New Method for Pipe Stresses—Parts I-III," K. Hao Hsiao, *Pet. Refiner*, Oct. 1955, Feb. 1956.
Part I—Oct. 1955, pp. 157-162.
How to use the tabular method; piping systems with constant moment of inertia; pipe stresses; right palm rule; tabulation form; examples, tables.
Part II—Nov. 1955, pp. 217-218.
Systems with different moments of inertia; examples.
Part III—Feb. 1956, pp. 153-157.
How to handle elbows and bends; equations, tables, forms, and examples.

"How Stresses Affect Branch Connections," E. D. Abraham and G. M. McClure *Pet. Refiner*, Feb. 1955, pp. 117-120.
Research results on design of unreinforced pipe line branch connections. Ratio of maximum to nominal stress in internal-pressure test; ratio of maximum to nominal stress in transverse-bend test; ratio of maximum to nominal stress in axial-bend test; principle stress directions in 4, 12 and 24-in. connections; distortion of 12 and 24-in. connections with internal pressure.

"Thermal Stresses in Piping Systems—PartsI-III," William E. Wilbur, *Pet. Refiner*, Mar.-May 1953.
Part I, Mar. 1953, pp. 143-148.
Principles and methods of analysis; expansion of piping; modulus of elasticity; the elastic center; thrusts; properties of steel pipe from 2 to 24 in. diameter; properties of 90° welding ells; flexibility of bends; approximation for round corners; examples.
Part II, Apr. 1953, pp. 163-168.
Symmetrical structures; preparing figures for lyre bends; structures with several sizes of pipes; movement of anchors; hinged anchor points; variation in pipe thickness, cold springing; stresses due to internal pressures; allowable stresses; dead loads; deflections; charts and graphs.
Part III, May 1953, pp. 174-178.
Three plane structures; multiple anchors; guides for expansion loops; yielding anchors; expansion loops using welding elbows; vertical deflection of loop; charts and graphs.

"Forces in Pipe Bends From Expansions," F. E. Wolosewick, *Pet. Refiner*, Oct. 1950, pp. 103-108.
Forces acting on pipe bends; mathematical analysis; analogy method; inertias of sections through centroid of pipe bends; illustrative examples, tight anchors; erosion and corrosion.

Expansion Joints

"Easy U Bend Design," John E. Brach, *Heat. Piping & Air Cond.*, Apr. 1955, pp. 99-101.
Rules for double offset expansion U bends. Bending stress computation; force on anchors; tabulated modulus of elasticity for various materials of construction; mean thermal expansion; moment of inertia for various size pipes.

"Complete Design Guide for Application and Selection of Flexon Expansion Joints," Flexonics Corp., *Catalogue 135*, 1953.
Types of expansion joints; specification data; construction; types of motion; design considerations; piping layout and applications; installation instructions; selection data; angular and lateral motion charts; tables; diagrams and examples.

"Take the Bite Out of Pipe Expansion," John Hyler, *Power*, Dec. 1952, pp. 128-129.
Illustrated discussion of expansion joints.

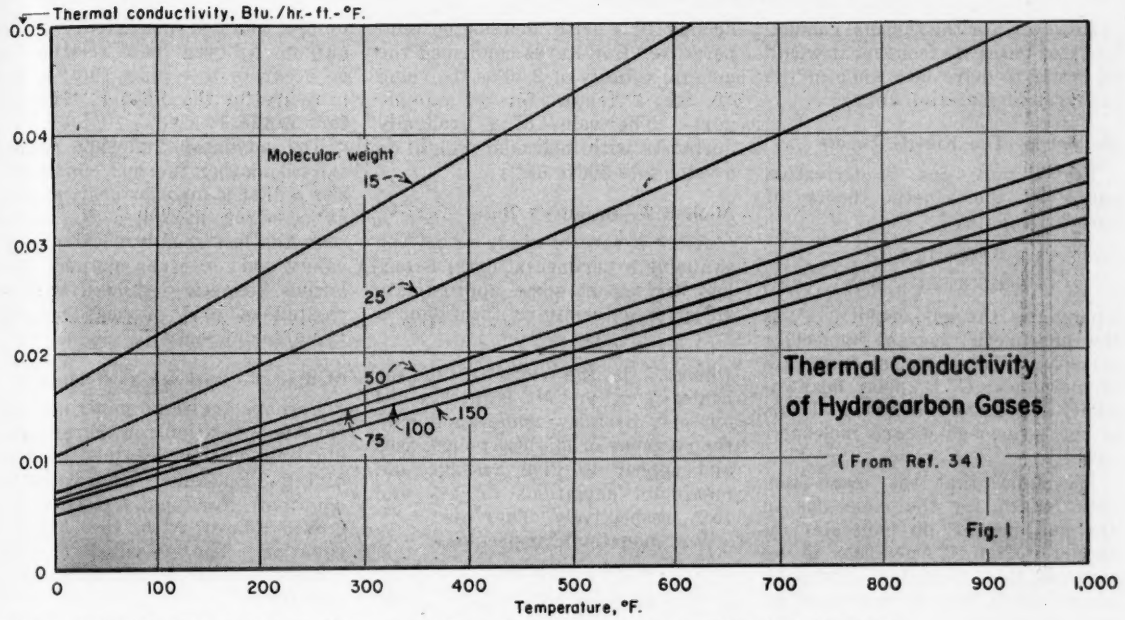
"Expansion of 'L' Type Bends," F. E. Wolosewick, *Pet. Refiner*, Sept. 1950, pp. 143-144.
Methods and graphs to be used in calculating L type bends.

"Expansion Joints—Their Maximum Spacing," Robert G. Blick, *Pet. Refiner*, July 1950, pp. 135-136.
Discussion of the problem of overspacing expansion joints as related to 'Euler Column instability failure.' Formulas developed; examples worked out; recommendations given.

"How to Select Corrugated Expansion Joints," A. B. White, *Industry & Power*, June 1950, pp. 106-110.
Expansion data and engineering information for choosing and applying the proper expansion joint. Figures are given to simplify expansion calculations for any length pipe. Types of joints; selection; design; thermal expansion table; nomograph for pipe thrust calculations; methods; of application; number of corrugations required for given movement; installation.

"Expansion Joints and Their Application," F. E. Wolosewick,*Pet. Refiner*, May 1950, pp. 146-150.
Use of bellows type joints where space limitations restrict layout or prevent use of pipe bends. Charts, graphs, examples.

"Expansion Joints For Industrial Piping," B. Maddock, *Industry & Power*, Nov. 1948, pp. 97-98.
Strain on fittings and equipment from thermal expansion or settling stress; bends; slip joints; accordian pleats for thrust relief. Temperature stress relationship (tabular); size of bends to allow for expansion.



WITH CHARTS such as this or with one of the calculation methods described in this article . . .

You Can Predict Gas Conductivity

Frequently required for design calculations, thermal conductivities are scattered through the literature. Now you can avoid the tiring search and calculate reliable values from basic fundamentals.

WALLACE R. GAMBILL, Carbide & Carbon Chemicals Co., Charleston, W. Va.*

In the first two articles of this series we discussed methods that can be used to estimate the thermal conductivity of liquids, liquid mixtures and solids (*Chem. Eng.*, Feb. 1957, p. 237; and March 1957, p. 271).

Now, here are the methods that you can use to estimate the thermal conductivity of gases and gas mixtures.

Methods for Gases

Experimental determination of the thermal conductivity of gases presents even greater difficulties than does that of liquids. With the presence of even small temperature differences, significant thermal convection currents exist and radiation effects must be considered and corrected for at higher temperature differences.

As a result, the number of reliable experimental values available is rather small. They may be found in the convenient compilations of either Daynes[1] or Bromley.[2]

Expressed in English engineering units of Btu./hr.-ft.-°F., the conductivity of gases under ordinary temperature-pressure conditions will fall in the range of 0.002 to 0.025 with 0.007-0.008 as a fair average.

Gas conductivity increases regularly with temperature and also with superatmospheric pressure (but to a lesser degree), and is largest for the small, light molecules. At low pressure (say 100-2,000 mm. Hg) the conductivity of gases is essentially independent of pressure; but k begins decreasing rapidly at a pressure of about 100 mm. Hg and finally decreases linearly with pressure at very low pressures (for below approximately 0.05 mm. Hg for heavy gases).

In general, predicting the thermal conductivity of a gas is more difficult than predicting its viscosity. The methods are less accurate.

However, in most cases we can make predictions of thermal conductivity that are accurate enough for engineering computations.

We'll Need Some Background

Our sequence of discussions will vary somewhat in this section from that used in other articles of this series. Usually we present the most useful methods first.

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However, for the thermal conductivity of gases we feel that it would be better to delve into some of the background material first.

Method 1—The Kinetic Theory

For a pure gas, a derivation based on the kinetic theory of gases[3, 4] leads to:

$$k = 0.333\ \rho\ V_a\ L\ C_v$$
$$k = 0.3065\ \rho\ V_{rms}\ L\ C_v \qquad (1)$$

where ρ is the gas density; V_a is the arithmetic average molecular velocity; L is the mean free path of molecules; C_v is molar heat capacity at constant volume; and V_{rms} is the root-mean-square molecular velocity.

We know that the mean-free-path length for the molecules in any gas depends on molecular diameter. Often, it's not easy to determine this diameter (although rough values may be estimated by various methods). Therefore, Eq. (1) is not easy to use.

Actually, the calculation is more often made the other way around: Mean free path is found indirectly from some property such as thermal conductivity and the diameter of the molecules is then computed from the mean free path.

However, the kinetic theory of gases leads to an expression for the coefficient of viscosity, μ, of gases:

$$\mu = 0.333\ \rho\ V_a\ L$$
$$\mu = 0.3065\ \rho\ V_{rms}\ L \qquad (2)$$

where the units are the same as those used in Eq. (1).

Combining Eqs. (1) and (2) yields the well-known Maxwell expression:[5]

$$k = \epsilon\ \mu\ C_v \qquad (3)$$

where the correction or magnification factor, ϵ, has been introduced to align the prediction of thermal conductivity with actual values.

Maxwell,[5] Meyer[6] and Jeans,[7] among others, each proposed values — semitheoretically derived — for the factor, ϵ (2.50, 1.53 and 1.497 were their respective suggestions).

It remained for Chapman[8] and Enskog,[9] however, to derive values with which today's experimental data are in general agreement: For monatomic molecules (field free and spherically symmetrical), use $\epsilon = 2.50$; for diatomic molecules, use $\epsilon = 1.90$; for triatomic molecules, use $\epsilon = 1.72$.

Measurements by Keyes[10] on the noble gases have shown a slight decline in ϵ with increasing temperature. But Keyes confirmed the general validity of 2.50 as the value of the ϵ factor for monatomic gases. The value of ϵ gradually decreases with molecular weight to a value just above unity.

Method 2—Bromley's Rules

After a careful study of all the available experimental data, Bromley[2] arrived at some approximate rules for determining the factor ϵ.

$$\epsilon = \gamma / N_{Pr}$$

where γ is the ratio of specific heats, C_p/C_v; and N_{Pr} is the Prandtl number. Bromley's rules apply only for nonpolar or slightly polar gases and appear to give average and maximum deviations of 4% and 15%, respectively. They are:

For monatomic molecules,

$$\epsilon = 2.4 + 0.016\ M^{0.5}$$
$$\epsilon \text{ is about } 2.5 \qquad (4a)$$

where M is the molecular weight of the gas.

For polyatomic, linear molecules,

$$\epsilon = 1.32 + 1.45(\gamma - 1) \qquad (4b)$$

except for H_2, NO and hydrogen halides.

For polyatomic nonlinear molecules,

$$[(9\ \gamma - 5)/4] < \epsilon < (1.29\ \gamma + 0.03) \qquad (4c)$$

Bromley's rules are of greater generality than those of Chapman and Enskog cited above. They represent the best values available.

When values of ϵ calculated from Eqs. (4a), (4b) and (4c) are used with the Maxwell equation,

$$k = \epsilon\ C_v \mu \qquad (3)$$

(where k is in Btu./hr.-ft.-°F.; C_v is in Btu./lb.-°F.; and μ is in lb./hr.-ft.) we can get approximate values for thermal conductivity of gases in the total pressure range of about 100-1,000 mm. Hg.

Method 3—Johnson and Huang

Following the same general approach, Johnson and Huang[11] presented a line chart of k vs. C_p and μ. Their chart is based on these relationships:

- For compounds with less than four carbon atoms, $k = 3.45\ C_p \mu$.
- For compounds with more than four carbon atoms, $k = 2.86\ C_p \mu$.
- For water and hydrogen sulfide, $k = 2.56\ C_p \mu$.

In these relationships k is in Btu./hr.-ft.-°F.; C_p is in Btu./lb.-°F.; and μ is in centipoises. The authors believed these relations to be accurate to within 10% at low pressure for the 0-600 F. temperature range.

The advantage of this method for calculating thermal conductivities is that it involves heat capacity at constant pressure, C_p, rather than the less readily obtainable C_v values used in other methods. Relations between C_p and C_v will be treated as part of heat capacity in an early issue.

Method 4—Eucken's Correction

Perhaps the most generally useful *single* relation for thermal conductivity is that obtained by combining Eucken's approximation equation[12] for the ϵ factor discussed above with the Maxwell equation. The so-called "Eucken correction expression" is given in this form:

$$\epsilon = \frac{9\ \gamma - 5}{4} = 1 + \frac{4.47}{C_v} \qquad (5)$$

where γ is the ratio of gas specific heats, C_p/C_v; and C_v is the molar heat capacity of the gas at constant volume.

Eucken's expression tends to take into account the transfer of energy between the translational and internal (rotational, vibrational) degrees of freedom during the collision of polyatomic molecules. This equation was originally obtained on an empirical basis, but was later rederived from a semitheoretical approach by both Eucken[13] and Meixner.[14]

Since γ in Eq. (5) is equal to 5/3 for monatomic gases and approaches unity as the number of atoms per molecule increases, the practical range for the ϵ factor is 1 to 2.5, as mentioned previously.

We can combine Eq. (5) with Eq. (3) and include the relation that C_v is equal to C_p minus R. This gives us the following:

$$k = \mu\left(C_p + \frac{2.48}{M}\right) \qquad (6)$$

where k is in Btu./hr.-ft.-°F.; μ is in lb./ft.-hr.; C_p is in Btu./lb.-°F.; and M is the molecular weight.

We can expect Eq. (6) to apply with fair accuracy (within 15%) to any gas at moderate or high temperature, and especially in the 100-1,000-mm.-Hg range. For high temperature—as in combustion—the molecular behavior of gases becomes more classical and Eq. (6)

Generalized Reduced Thermal Conductivities For The Gas Phase

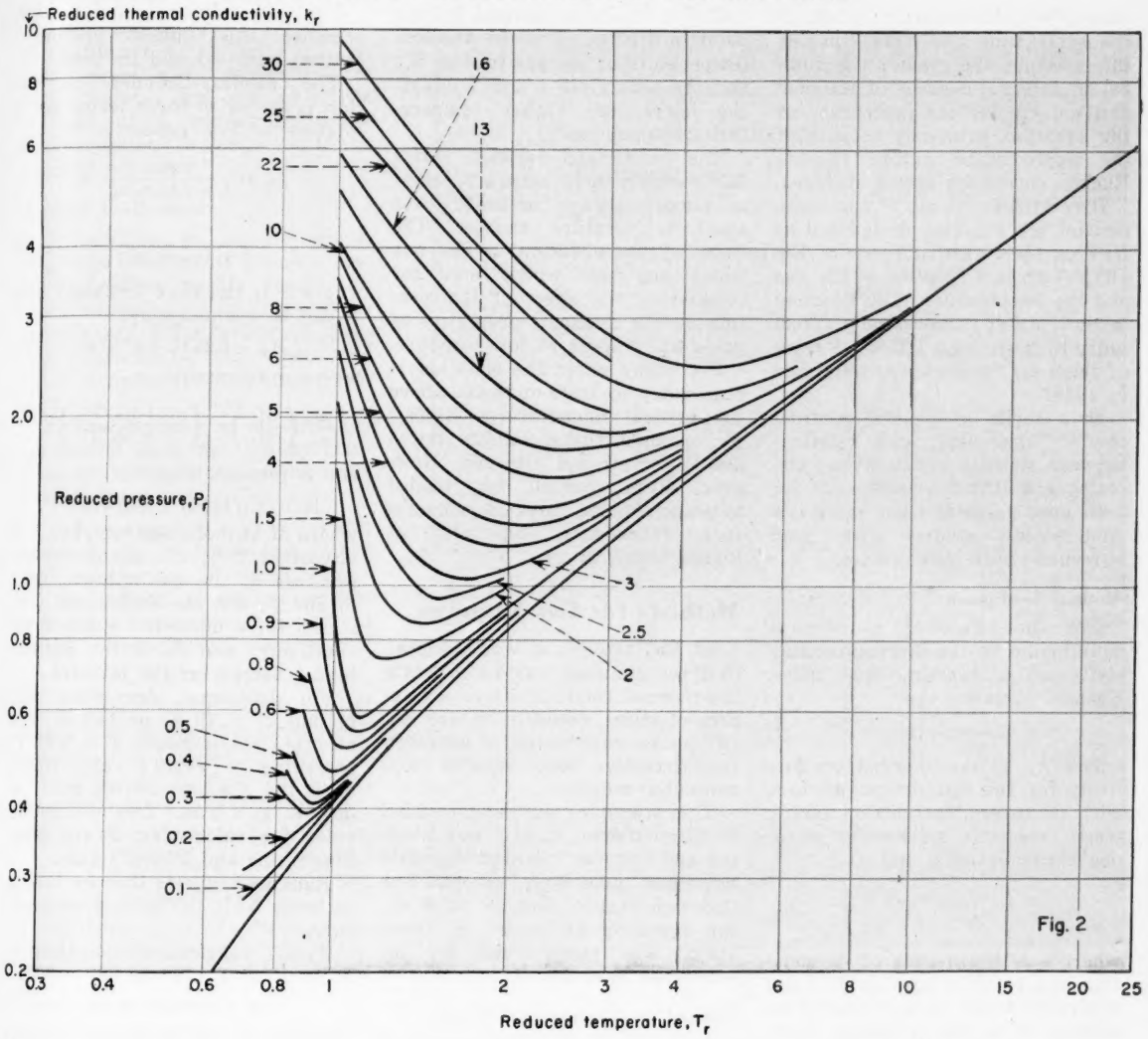


Fig. 2

Selected Values of Calculated Critical Thermal Conductivities

Critical thermal conductivity, k_c = Btu./hr.-ft.-°F.

Compound	k_c	Compound	k_c	Compound	k_c
Acetone	0.0400	Ethane	0.0290	Methyl chloride	0.0272
Acetylene	0.0340	Ethyl acetate	0.0433	Neon	0.0124
Air	0.0165	Ethyl chloride	0.0378	Nitric oxide	0.0234
Ammonia	0.0611	Ethyl ether	0.0421	Nitrogen	0.0157
Argon	0.0136	Ethylene	0.0276	Nitrous oxide	0.0256
Benzene	0.0427	Helium	0.0088	Oxygen	0.0199
n-Butane	0.0380	n-Hexane	0.0452	n-Pentane	0.0416
Carbon dioxide	0.0244	Hydrogen	0.0366	Propane	0.0343
Carbon dioxide	0.034*	Hydrogen chloride	0.0260	Propylene	0.0317
Carbon disulfide	0.0229	Hydrogen cyanide	0.0406	Sulfur dioxide	0.0238
Carbon monoxide	0.0182	Isobutane	0.0380	Toluene	0.0457
Carbon tetrachloride	0.0199	Isopentane	0.0408	Water	0.0875
Chloroform	0.0225	Isopropyl alcohol	0.0492	Water	0.121*
Cydohexane	0.0504	Krypton	0.00922	Xenon	0.00801
Dichlorodifluoromethane	0.0205†	Methane	0.0285		
		Methyl alcohol	0.0620		

NOTE:—Unless otherwise noted all values are from I. Granet, Ref. 28. *These values from M. Jakob, Ref. 35. †Value for dichlorodifluoromethane from B. W. Gamson, Ref. 27.

should be quite accurate; while at the same time the more complex the molecule, the greater the number of internal degrees of freedom and the greater the inaccuracy of the equation, primarily because of the approximate nature of the Eucken correction factor included.

Hirschfelder, et al.,[15, 16] include a multiplying function designated as H/V on the right-hand side of Eq. (6), which is a function of the gas and the temperature. The function doesn't differ theoretically from unity by more than 1.25%. A table of these H/V values was published in 1948.[17]

In a series of papers, Andrussow[18, 19, 20] has dealt with relations between thermal conductivity, viscosity and diffusion coefficients for both pure gases and gas mixtures. Andrussow's studies give good agreement with other values.

Method 5—Franck

For the effect of a chemical equilibrium on the thermal conductivity of a reacting gas mass, Franck[21] proposed that

$$k = k_m + k\alpha \qquad (7)$$

where k_m is the thermal conductivity for the equilibrium mixture with no reversible reaction taking place (see later section for methods of calculation); and

$$k\alpha = \frac{DP\,(\Delta H)^2\,\alpha\,(1-\alpha)}{R^2\,T^3\,(1+\alpha)} \qquad (8)$$

where α is the degree of dissociation in a reaction such as X_2 going reversibly to $2X$; ΔH is heat of reaction; D is the diffusion coefficient of the product; R is the universal gas constant; T is absolute temperature; and P is total gas pressure.

In words, $k\alpha$ is the incremental contribution to the total effective conductivity arising from the reversible equilibrium; it equals zero when α is equal to zero and unity, and passes through a maximum at intermediate values of α.

Method 6—Sutherland's Equation

Variation of the thermal conductivity of a gas with temperature, at low pressures, can be evaluated through the Sutherland equation:[22]

$$k_2 = k_1\left(\frac{T_1+S}{T_2+S}\right)\left(\frac{T_2}{T_1}\right)^{1.5} \qquad (9)$$

where S is the Sutherland constant which is approximately equal to 1.47 T_b; T_b is the normal boiling point in deg. K.; T is the absolute temperature of the gas in deg. K.; and the subscripts 1 and 2 denote the lower and higher temperatures, respectively.

The Sutherland relation varies fairly widely in its accuracy, but it is almost always accurate over small temperature ranges. The form of the equation is the one which has been widely used for correlating the effect of temperature on the transport properties of gases and vapors at low pressure.

For many gases the equation is reasonably accurate up to and above the critical temperature. Stops,[23] for example, found validity up to 600 C. for air and nitrogen. However, Stops' over-all data tended to show a cubic form of temperature dependence, especially at higher temperatures.

Methods for Gas Mixtures

At first thought it would appear that the simplest way to calculate the thermal conductivity of a mixture of gases would be to use Eq. (6) above, with weighted averages for viscosity, heat capacity and molecular weight.

This procedure was recommended by Hirschfelder, et al.,[15] but Lindsay and Bromley[24] showed that this technique gave large errors. For hydrogen-carbon dioxide at 0 C., for instance, an error of about 100% was encountered for an equimolar mixture.

Method 1—Lindsay and Bromley

Lindsay and Bromley[24] developed a correlation that is undoubtedly the most accurate available today. It may be used for any gas mixture at low or moderate pressures.

To use this method we must know the pure component thermal conductivities or else estimate them by the methods outlined above. Using this approach the average deviation for 85 different compositions of 16 gas pairs was plus or minus 1.9%, and the maximum error was 10.0%.

Practically every paper written on the thermal conductivity of gas mixtures since 1950 has included a comparison of the experimental values with those calculated by the Lindsay and Bromley method. In general, agreement is excellent—within 2%—but isolated instances of large errors have been noted.

For gas mixtures under high pressure, the Gamson method—treated later—should be used.

The Lindsay-Bromley correlation is stated in these terms for a mixture of two gases:

$$k_m = \frac{k_1}{1+(A_{12}\,x_2/x_1)} + \frac{k_2}{1+(A_{21}\,x_1/x_2)} \qquad (10)$$

where x is the mole fraction; and A can be evaluated by:

$$A_{12} = 0.25\,(1+a^{0.5})^2\,b \qquad (11)$$

where a represents

$$\frac{\mu_1}{\mu_2}\left(\frac{M_2}{M_1}\right)^{0.75}\left(\frac{1+(S_1/T)}{1+(S_2/T)}\right)$$

and b represents

$$[1+(S_{12}/T)]/[1+(S_1/T)]$$

where M is molecular weight; μ is viscosity; T is the absolute temperature of the gas mixture, °K.; S_1 and S_2 are the Sutherland constants for components 1 and 2 respectively; and S_{12} is the Sutherland constant for the mixture.

For hydrogen, deuterium and helium, $S = 79$ K. or 142 R. For all other *single* gases, $S = 1.47\,T_b$ according to Vogel's rule; where T_b is the absolute boiling point in deg. K. at 1 atm. Two alternative rules for calculating S are Rankine's rule and Fisher's rule.

Rankine suggests that we take S as being 0.878 the critical temperature.

Fisher suggests this method in *Phys. Rev.*, Vol. 24, p. 385 (1907):

$$S = 0.058\,M^2 + 74$$

where M is the molecular weight.

For the collision of unlike nonpolar gas molecules, S_{12} is the geometric mean:

$$S_{12} = (S_1\,S_2)^{0.5} \qquad (12)$$

and when one component has a strong dipole and is highly polar:

$$S_{12} = 0.733\,(S_1\,S_2)^{0.5} \qquad (13)$$

Eq. (13) would apply to steam or ammonia, for example.

These simplified methods for estimating the Sutherland constant are justifiable since an error of 20% in S affects the calculated thermal conductivity of the mixture by only about 1%. The constant S is supposedly a measure of intermolecular attractive force, but some doubt has been cast on this viewpoint in recent years. Typical values, all in deg. R., are: O_2, 248; SO_2, 749; CO_2, 493; NH_3, 679; and

air, 217(199 to 225 have been proposed for air).

It's possible to generalize Eq. (10) to cover the case of a gas mixture of n components. For these equations, we refer you to the original reference.[24]

Method 2—Brokaw

Brokaw[25] has proposed a simple empirical relationship which is useful for estimating the conductivities of nonpolar gas mixtures whose constituents differ widely in thermal conductivity, and where the effect of molecular weight is dominant.

Brokaw represented available experimental data for binary mixtures of hydrogen or helium with heavier gases by:

$$k_m = a\,k_{sm} + (1 - a)\,k_{rm} \qquad (14)$$

where a is a dimensionless factor that is a function of concentration; and the subscripts sm and rm denote simple mixing and reciprocal mixing, respectively. Further,

$$k_{sm} = y_1\,k_1 + y_2\,k_2 \qquad (15)$$

$$1/k_{rm} = (y_1/k_1) + (y_2/k_2) \qquad (16)$$

where y is the mole fraction of a component in the gas mixture.

Combining the relations above, we obtain for a binary mixture:

$$k_m = a\,(y_1\,k_1 + y_2\,k_2) + (1 - a)\,\frac{k_1\,k_2}{y_1\,k_2 + y_2\,k_1} \qquad (17)$$

The factor a varies with gas composition as indicated in the table below:

Mole Fraction of Lighter Component	a
0	0.32
0.1	0.34
0.2	0.37
0.3	0.39
0.4	0.42
0.5	0.46
0.6	0.50
0.7	0.55
0.8	0.61
0.9	0.69
0.95	0.74
1.0	0.84

Comparing calculated values—from Eq. (17) and the table above—with experimental data for the conductivities of 113 mixtures of 18 gas pairs showed good agreement, with average and maximum deviations of 2.6% and 11.4% respectively.

For multicomponent mixtures of more than two gases, $a = 0.5$ for all compositions can be used as a rough approximation. Burgoyne and Weinberg[26] used this approximation to get:

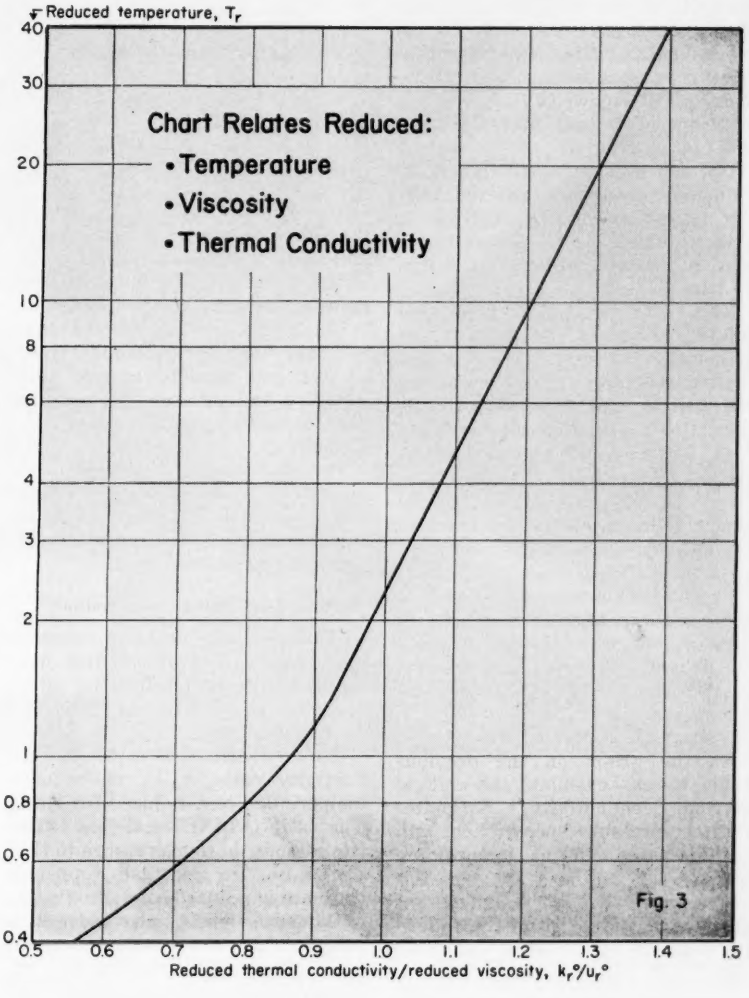
$$k_m = (k_{sm} + k_{rm})/2$$

$$k_m = 0.5\ \Sigma\, y_i\,k_i + 0.5/[\,\Sigma\,(y_i/k_i)] \qquad (18)$$

Comparison with experimental data for a few three- and four-component gas mixtures gives generally good agreement — within about 6%. However, remember that this method is inapplicable to gas mixtures that contain highly polar components such as steam or ammonia. The Lindsay-Bromley method—using properly adjusted Sutherland constants—is preferable for this case.

Method 3—Bird, et al.

For binary mixtures of heavy elemental isotopes, Bird, et al.,[16] have shown the following relationship to be correct:



$$\frac{1}{k_m^{0.5}} = \frac{x_1}{k_1^{0.5}} + \frac{x_2}{k_2^{0.5}} \qquad (19)$$

where x is mole fraction; and the subscripts m, 1 and 2 denote the mixture, component 1 and component 2, respectively.

Effect of Pressure

Several investigators have correlated the effect of pressure on thermal conductivity.

Method 1—Gamson

Gamson[27] gives a generalized correlation for the gas state by means of which we can calculate the thermal conductivity of gases under all conditions.

If we know one experimental value of conductivity, we can get a value for the critical thermal con-

ductivity, k_c, of the gas from the temperature and pressure of the experimental value. Then we can use this value of k to calculate thermal conductivity at any other value of temperature and pressure (see chart on p. 279.

Gamson considered all classes of compounds and it is believed that the reliability of the method is plus or minus 15%. Accuracy is best in the reduced-pressure range of 1 to 10.

The table[28] on p. 279 gives calculated k_c values for many gases of common interest. When no experimental data are available, we can use this relation to estimate the critical thermal conductivity:

$$k_c = \frac{\mu_r^{\circ}\mu_c}{k_r^{\circ}}\left(C_p^{\circ} + \frac{2.48}{M}\right) \qquad (20)$$

where the superscript o indicates the ideal gas state at low pressure; μ_r is the reduced viscosity $= \mu/\mu_c$; μ_c is critical viscosity in lb./ft.-hr.; k_r = reduced thermal conductivity $= k/k_c$; M is molecular weight; C_p° is zero-pressure specific heat in Btu./lb.-°F., and at the critical temperature.

Using Eq. (20) in conjunction with the graph on the previous page, we can calculate the critical thermal conductivity. Estimates for zero-pressure specific heat will be discussed in a forthcoming issue.

The critical viscosity of a gas may be calculated from the following relation of Uyehara and Watson:[29]

$$\mu_c = \frac{0.00077\, M^{0.5}\, P_c^{0.667}}{T_c^{0.167}} \qquad (21)$$

where μ_c is the critical viscosity in centipoises at T_c and P_c; M is molecular weight; T_c is critical temperature in °K.; and P_c is critical pressure in atm.

We plan to present a list of critical viscosities in the viscosity section of this series of articles.

Thus, knowing the ratio of μ_r° to k_r° as the reciprocal of the value read from the abscissa of the chart above (see page 281) and having computed C_p° and μ_c, we then use Eq. (20) to calculate the critical thermal conductivity.

For mixtures, Gamson recommends the use of Kay's rules. Assume that the thermal conductivity of the mixture at its pseudocritical point is equal to the molal average of the pure-component critical conductivities as given by:

$$k_c' = \sum_{i=1}^{i=n} y_i\, k_{ci} \qquad T_c' = \sum_{i=1}^{i=n} y_i\, T_{ci}$$

$$P_c' = \sum_{i=1}^{i=n} y_i\, P_{ci}$$

where y is the mole fraction; i is the i-th component; a prime mark indicates the pseudocritical state of the mixture, and c is the critical state of the pure components.

Using these rules we can then estimate the thermal conductivity of any gas mixture at any temperature and pressure by estimating from the pseudoreduced conditions.

For moderate conditions, the mixture law discussed previously (Lindsay and Bromley) is best; for extreme temperature and pressure, use Gamson's method.

Method 2—Comings and Nathan

Comings and Nathan[30] proposed what was probably the first generalized correlation for the effect of pressure on the thermal conductivity of gases.

This correlation is a plot of conductivity ratio, k_p/k_1, vs. reduced temperature and reduced pressure. The ratio is of thermal conductivities at some higher pressure to that at 1 atm. In contrast, Gamson's ordinate is reduced conductivity, k_r.

Gamson's chart also covers a broader range of reduced conditions (but with decreasing accuracy at extreme conditions). The Comings-Nathan chart requires knowledge of low-pressure thermal conductivities as a function of temperature; Gamson's does not.

Lenoir and Comings[31] checked their chart with experimental data for seven gases in the 1- to 200-atm. pressure range and found average and maximum (in the region of the critical point) errors of 4% to 20%, respectively.

Method 3—Franck

Franck[32] proposed an approximate relation connecting the pressure functionality of k with that of specific heats and specific volume.

Enskog[33] has also treated this same problem analytically.

For hydrocarbon gases only, Maxwell[34] has proposed the graph that we show as the frontispiece for this article.

The accuracy is fair and the values can be used for most engineering calculations.

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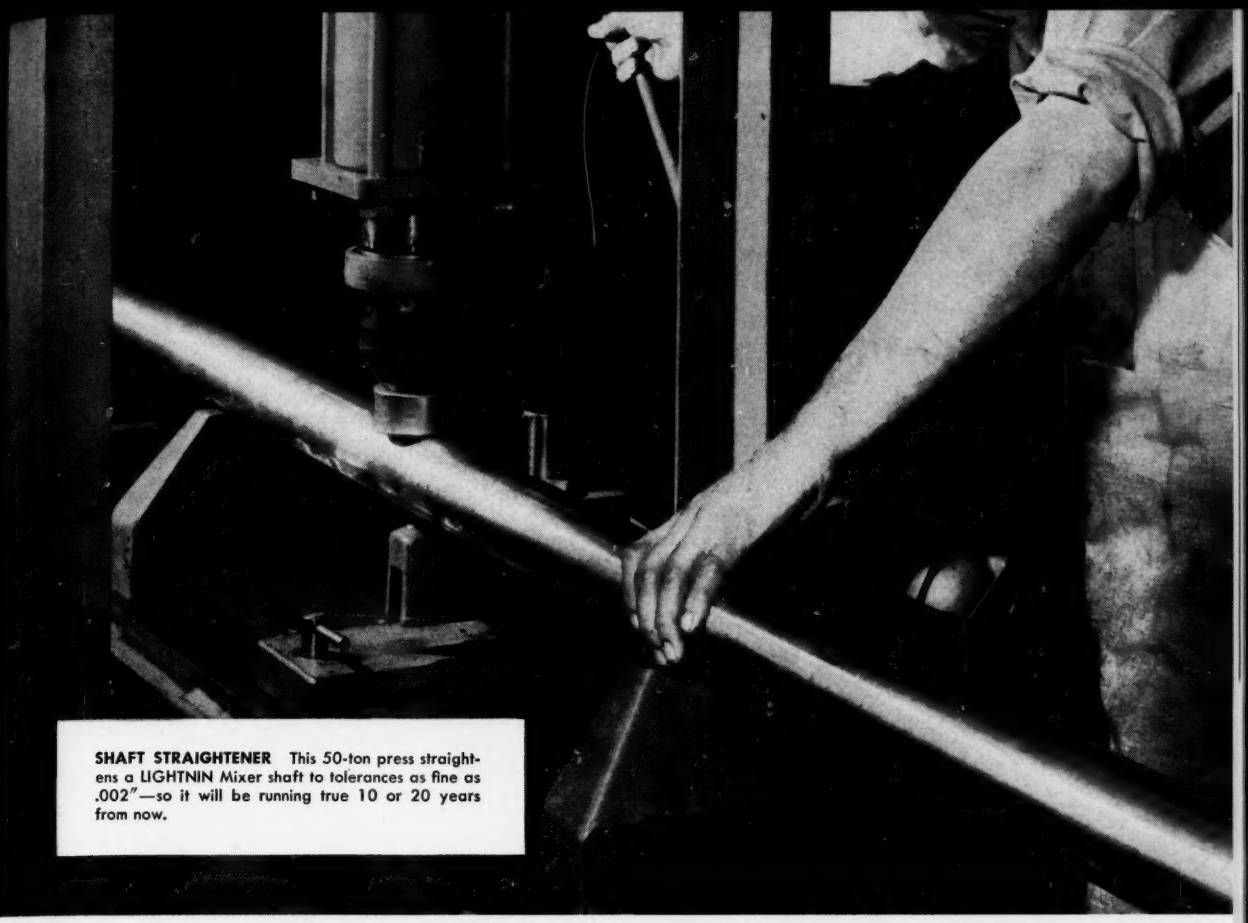

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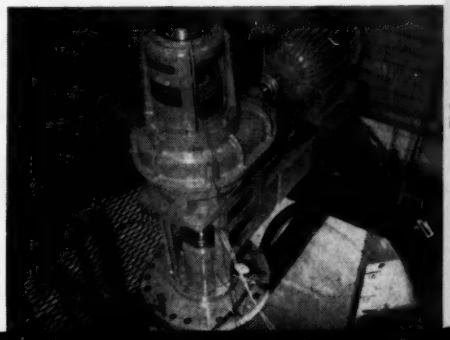

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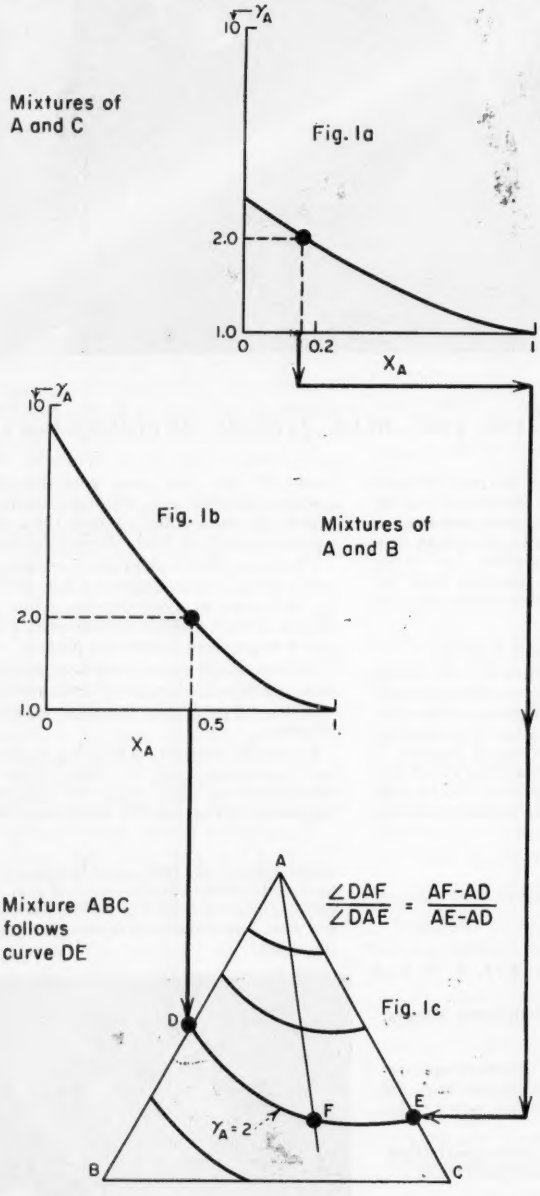
With a Third Component . . .

Design for Physical Equilibrium

- **Through Activity Coefficients of Binary Mixtures**
- **Through Boiling-Point Measurements**

JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*



In last month's installment (*Chem. Eng.*, Mar. 1957, p. 278) we demonstrated how to represent three-component equilibrium relations. We obtained the necessary data for plotting by holding temperature and pressure constant, thus reducing the number of variables to two composition terms. By this method we were able to read two composition terms from a graph and calculated the third.

In this second installment, we continue our discussion of three-component vapor-liquid equilibrium.

Let us start by reviewing the methods that have been proposed for obtaining ternary diagrams.

Ternary Diagrams From Binary

Three-component equilibrium data are harder to measure than two-component, and they are much scarcer. For a long time, people have hoped to find a way to put together three binary diagrams to make a ternary.

The problem has been approached by two methods—mathematical and graphical. Both use activity coefficients, and both have been fairly successful. The mathematical approach has been developed by Wohl in *Trans. AIChE*, **41**, p. 539 (1946). [Corrections and additions to this article are published in *Chem. Eng Progress*, **49**, p. 218, (1953)]. The method is an extension of the van Laar equations to include three components.

If you want to use these equations you first calculate the constants $[C]$ in the van Laar equation for each of the three binary systems:

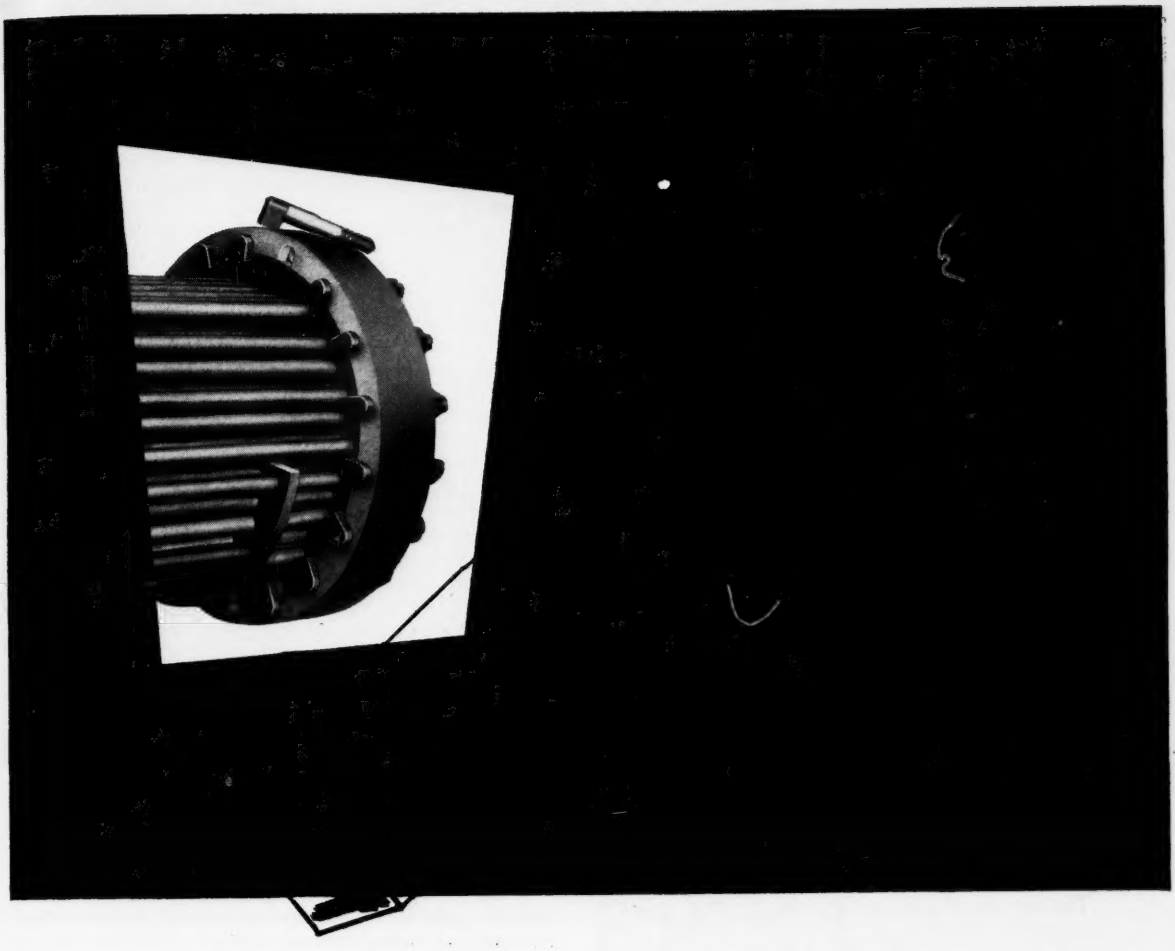
$[C]_{AB}$ and $[C]_{BA}$ for mixtures of A and B
$[C]_{BC}$ and $[C]_{CB}$ for mixtures of B and C
$[C]_{AC}$ and $[C]_{CA}$ for mixtures of A and C.

(The first letter in the subscript tells which material the constant refers to; the second tells what other material is present.)

In simple cases, log γ can be calculated from these values by an equation which Wohl derives. In other cases, we need one ternary equilibrium value to use in another equation.

In addition to the van Laar equations, the same author also gives equations based on the Margules equations. Both sets of equations contain a large number of terms and are rather complicated, and we won't give them here. Instead, we're going to

Meet your author on p. 328.



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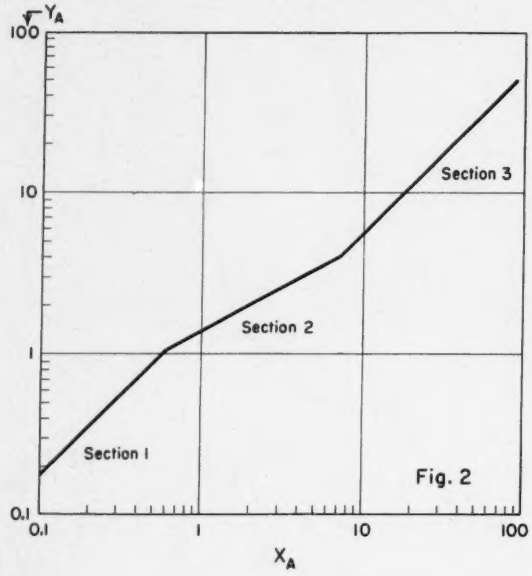
Find ternary diagrams via boiling-points



show a graphical method first proposed by Scheibel and Friedland, in *Ind. Eng. Chem.* **39**, p. 1329, (1947).

Interpolating Activity Coefficients

The object of this method is to draw a three-component diagram on which the activity coefficients are plotted. We will prepare this diagram from constant pressure data on two-component systems. The activity coefficient is not very sensitive to pressure or temperature, so the diagram can be used at other conditions.

Just as in binary systems, we define the activity coefficient by the relation

$$\gamma_A = \Pi y_A / P_A x_A \qquad (1)$$

In a binary mixture γ_A depends on x_A. In a ternary system, it depends on both x_A and x_B. To show how we interpolate the data to get γ in ternary mixtures, let's use Fig. 1.

In Fig. 1*b*, we have γ_A plotted against x_A, for mixtures of *A* and *B*. This curve is calculated from experimental data on these two substances. It may correlate with the van Laar equation, but it doesn't have to. We have the same information for mixtures of *A* and *C* in Fig. 1*a*. Now let's put a line of constant γ_A on the triangular diagram, say for $\gamma_A = 2.0$. From Fig. 1*b*, $\gamma_A = 2$ when $x_A = 0.5$. This locates point *D* on line *AB*. From Fig. 1*a*, $\gamma_A = 2$ when $x_A = 0.2$, locating point *E* as shown. Now we have the two end points on the line of constant γ. How does the curve go between these points? Scheibel and Friedland showed that the method which we'll describe gave activity coefficients which agreed well with measured values for all six systems they tested.

We locate intermediate points on the line by the following rule: Make the radius *AF* vary in length from *AD* to *AE* in direct proportion to the angle *DAF*. In this way we sketch in the curve for $\gamma_A = 2.0$. Also, by similar construction we can draw lines for other values of γ_A. And from binary curves of γ_B in mixtures of *A* and *B* and of *B* and *C*, we draw the curves of constant γ_B. So also with γ_C.

For regions of high γ, a given value of γ is not found on two edges of the triangular diagram. We have to use some guesswork in this region, and draw the lines parallel to those we have already located. This procedure works only if γ is greater than one for all three substances. This takes in most mixtures in which we are interested. For the exceptions see article by Scheibel and Friedland.

After we have the diagram showing all three activity coefficients as a function of composition, we can use vapor pressure data to calculate vapor compositions. First assume a temperature; find P_A, P_B and P_C. Calculate $P_A x_A \gamma_A$, $P_B x_B \gamma_B$ and $P_C x_C \gamma_C$. The sum should equal the total pressure. If not, adjust the temperature and repeat. Then calculate

$$y_A = P_A x_A \gamma_A / \Pi \qquad (2)$$

This procedure is the same as for binary systems.

Equilibrium Data From Boiling Points

A new method developed by Hirata [*AIChE Journal*, **1**, p. 354, (1955)] allows us to calculate vapor-liquid equilibrium compositions from boiling-point measurements in ternary systems. This method depends on a new correlation of vapor-liquid equilibrium data, and equations derived from this correlation.

Suppose we define new composition variables, *X* and *Y*:

$$X = x/(1 - x) \qquad (3)$$

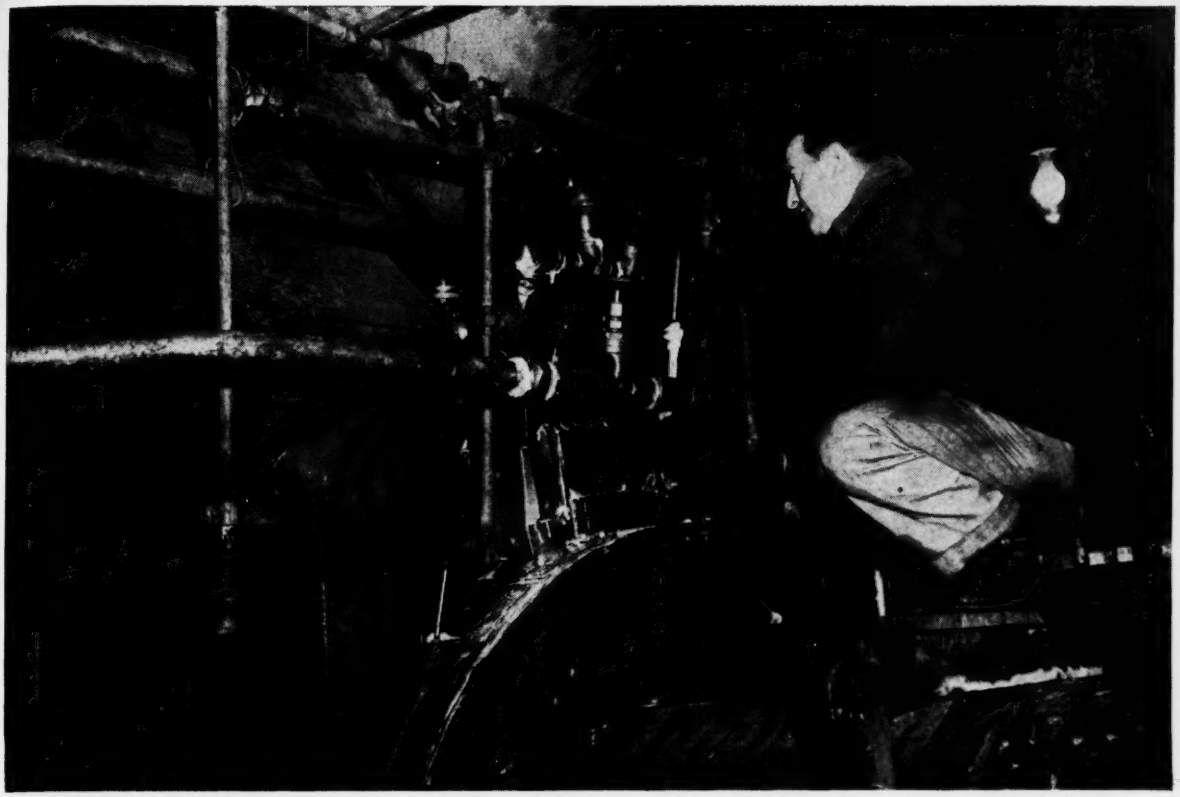
$$Y = y/(1 - y) \qquad (4)$$

If we plot Y_A against X_A for a number of liquid mixtures which have the same ratio of x_B/x_C, we get a curve like that shown in Fig. 2.

Using thermodynamics, Othmer, Ricciardi and Thaker [*Ind. Eng. Chem.*, **45** p. 1815, (1953)] derived equations for the three straight-line portions of such curves. To use these equations, we need boiling-point curves and heats of vaporization.

Nomenclature (Consistent Units)

A,B,C	Pure substances in equilibrium
[*C*]	Constant in van Laar equation as indicated by subscript
ΔH	Heat of vaporization of substance as indicated by subscript
P	Vapor pressure of pure substance indicated by subscript
R	Gas constant
T	Absolute temperature
X	Composition variable
Y	Composition variable
x	Mole fraction in liquid phase
y	Mole fraction in vapor phase
α	Slope of sections of curve in Fig. 2 as indicated by subscript
γ	Activity coefficient
Π	Total pressure



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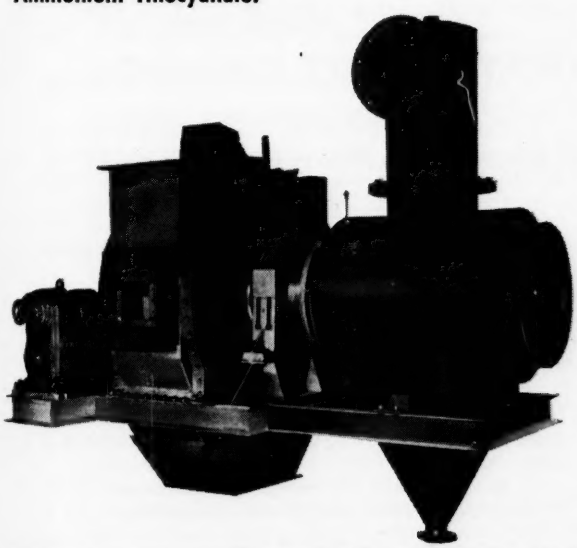

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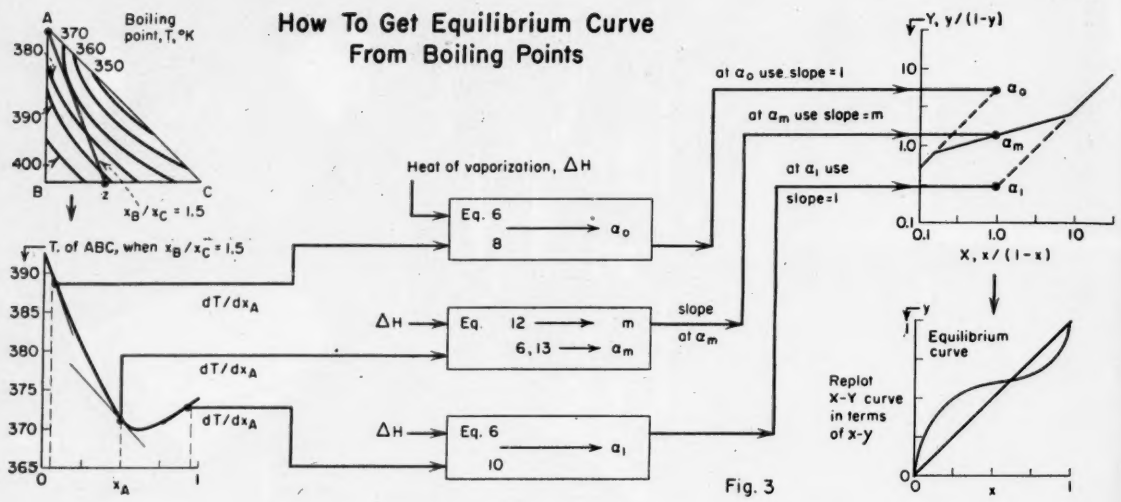


Fig. 3

First, we'll list the equations; then we'll show how we use them to predict vapor-liquid equilibrium from those data.

First, we calculate a term $f(T)$. For a binary system,

$$f(T) = (\Delta H/RT^2)\,(dT/dx)\,P \tag{5}$$

For a ternary system, we use the equation

$$f(T) = \frac{(\Delta H_A/RT_A)X_A + (\Delta H_{BC}/RT_{BC})\,(1 - x_A)}{T} \times \left(\frac{dT}{dx_A}\right)P \tag{6}$$

Here, ΔH_A is the heat of vaporization of a pure A at its boiling point T_A.

ΔH_{BC} is the heat of vaporization of a binary mixture of B and C containing a fraction of B equal to $x_B/(x_B + x_C)$, at its boiling point.

The slope of the boiling point curve at constant pressure is $(dT/dx_1)P$.

The equation of Section 1 of the curve in Fig. 2 is

$$Y = \alpha_0 X \tag{7}$$

where

$$\alpha_0 = \frac{1 - f_0\,(T)\,(1 - x_A)}{1 + f_0\,(T)\,x_A} \tag{8}$$

and $f_0(T)$ is calculated from the boiling points and heat of vaporization at x_A, in the region near $x_A = 0$.

The equation of Section 3 is

$$Y = \alpha_1 X \tag{9}$$

where

$$\alpha_1 = \frac{1 - f_1\,(T)\,(1 - x_A)}{1 + f_1\,(T)\,(x_A)} \tag{10}$$

and $f_1(T)$ is evaluated at x_A in the region near $x_A = 1.0$.

Finally, the equation of Section 2 is

$$Y = \alpha_m X^m \tag{11}$$

$$m = [\alpha_1/\alpha_0 - 0.03]^{0.375} \tag{12}$$

$$\alpha_m = X^{1-m}\left[\frac{m - f_m\,(T)\,(1 - x_m)}{m + f_m\,(T)\,x_m}\right] \tag{13}$$

These equations were derived from a great many binary data and some ternary systems. Let's see how to get vapor-liquid equilibrium. We need:

- Heats of vaporization
- Boiling points of a number of mixtures.

Refer to Fig. 3 for the steps we take to derive the x-y curve from these data.

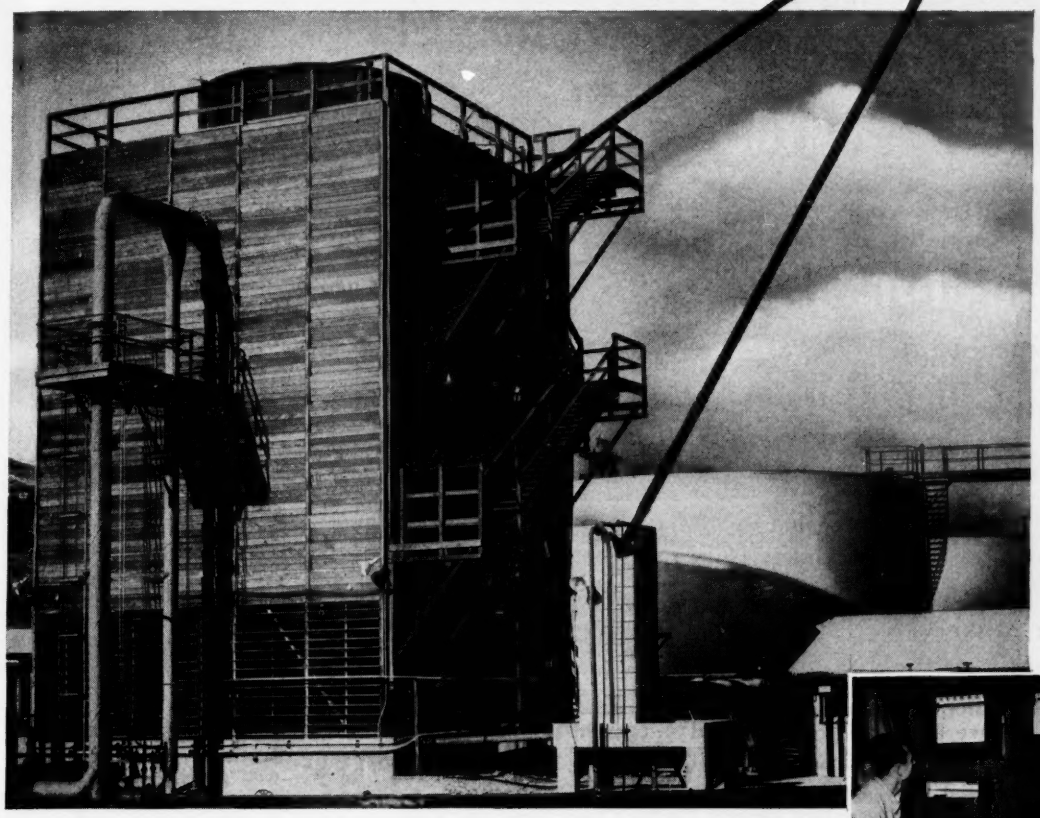
1. Plot the boiling point data as lines of constant boiling point.
2. Draw line A-z to give compositions with a constant ratio $x_B/x_C = 1.5$.
3. Make a cross-plot of boiling points vs. x_A for these compositions.
4. At $x_A = 0.05$, measure the slope of the boiling point curve, dT/dx_A.
5. Calculate $f_0(T)$ by Eq. 6. ΔH_{BC} is the heat of vaporization of a binary mixture of B and C with a ratio of $x_B/x_C = 1.5$, and T_{BC} is the boiling point.
6. Calculate α_0 by Eq. 8. This is the intercept at $X = 1.0$ of the lower section of the X-Y curve. Use log paper and draw this part of the curve through α_0 with a slope of 1.0
7. From the slope of the boiling point curve at $x_A = 0.95$, calculate $f_1(T)$ and α_1 by Eq. 6 and 10. This is the intercept at $X = 1.0$ of the upper part of the curve. Draw this part of the curve with a slope of 1.0.
8. Calculate m by Eq. 12, then α_m by Eq. 13. Locate α_m at $X = 1.0$, and draw a line through it with slope m.
9. We now have the complete equilibrium curve. Choose values of X and Y, and convert to x and y.

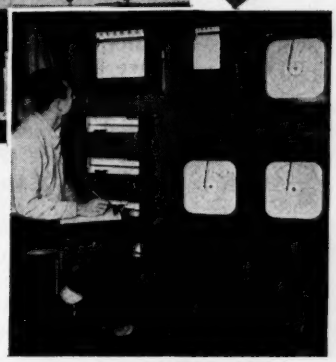
$$x = X/(1 - X) \tag{14}$$

$$y = Y/(1 - Y) \tag{15}$$

This process must be repeated for several different ratios x_B/x_C, and again for x_B at constant ratio x_A/x_C. This makes it a rather involved process, but it is probably easier than taking equilibrium data.

TESTING—1, 2, 3





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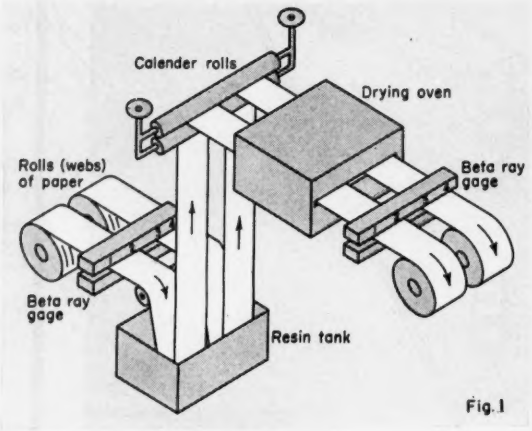


Fig. 1

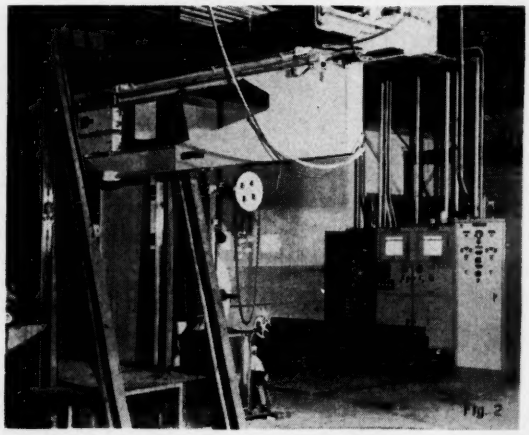


Fig. 2

★ Winner of January Contest

Automatic Controller for Impregnation

Automatic controls on a continuous resin impregnator gave a better product, paid out in less than a year.

R. J. Rieke and D. C. Fisher
General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

A new automatic control system for phenolic resin impregnation of kraft paper has been in use for over a year at General Electric Co.'s Coshocton, Ohio, plant. The savings it produces, in comparison with the previous manual control, have been enough to pay for the controller (including its development) in less than one year. These savings result from (1) a 40% reduction in the material produced that is outside the tolerance limits of low or high resin content; and (2) the ability to control closer to the more economic of the two limits. Production has become more uniform, thus resulting in a consistently better product.

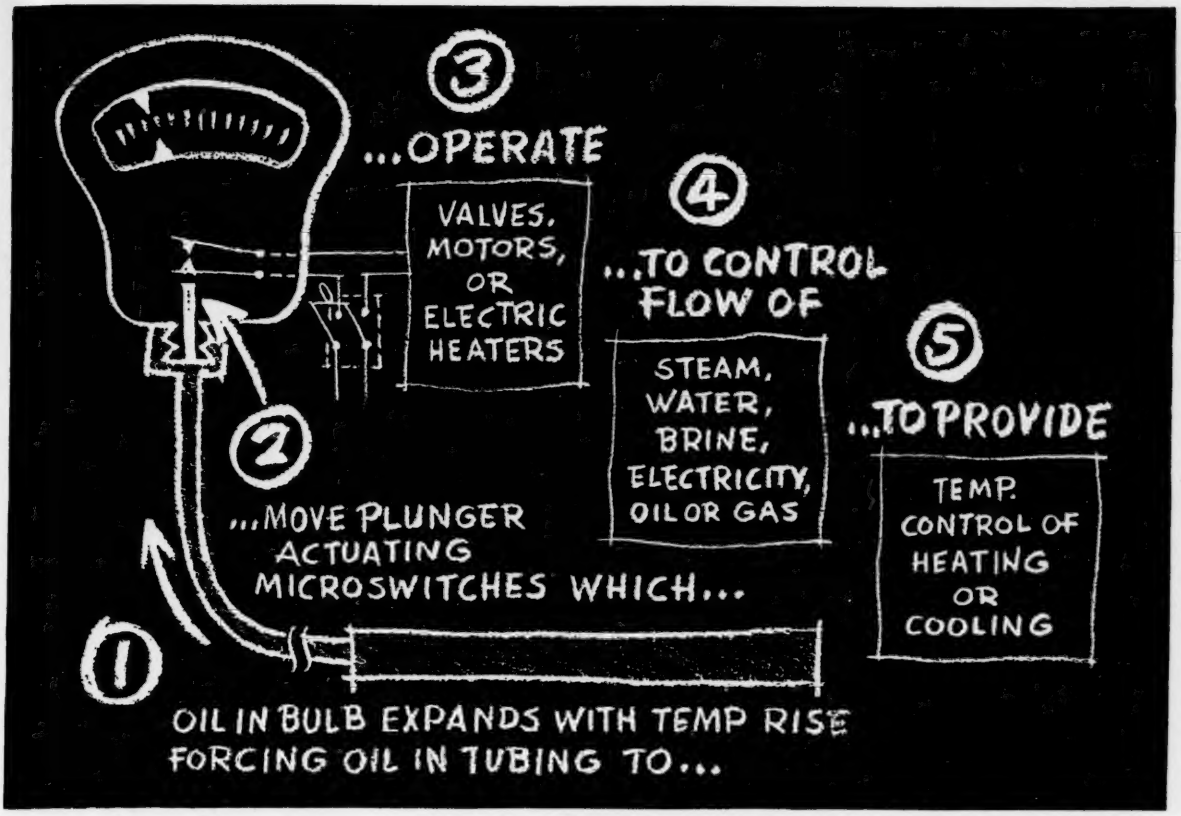
In this installation the treating equipment is wide enough to handle either one or two rolls of paper. The impregnating process, diagrammed in Fig. 1, consists of passing the paper through a resin tank. The wet paper is then fed through calender rolls, the spacing of which controls the resin content. Finally the web is passed through a dryer and is rewound. To form laminated sheet the treated paper is later cut to length, stacked to the desired thickness and cured in a heated press.

The resin content of the treated paper is determined by two beta-ray gages, one ahead of the dip tank and one after the dryer. These gages measure the mass density before and after impregnation. From this the percentage resin content is continuously computed and recorded by the gage equipment. Character of the product places an upper and lower limit on the percentage resin content. Adjustment of the calender roll spacing is made to keep the resin content near the more economical of the two limits. Whether this is the upper or lower limit is a function of the relative cost of paper (or cloth) and resin. Resin costs more than paper, but less than cloth, if the latter material is being impregnated.

The gages, which are about 100 ft. apart, are programmed to measure simultaneously in sequence the edges of the paper; they measure for 80 sec. at each of two or four positions (one- or two-web operation). In one-web operation, if the paper is thicker on one edge, the calender setting can be adjusted to compensate. In two-web operation only a compromise can be achieved since the profiles may differ.

Previous to the installation of the control equipment the operator manually positioned the calender rolls to keep the resin content within limits. This he had to do within 6° of handwheel rotation, in the presence of 60° of backlash. Thus he operated much as you would operate a lathe, i.e., adjust only in the closing direction to eliminate the effect of backlash. Because of errors in judgment, as well as other duties, his corrections were not always accurate and timely. Since the installation of automatic control all corrections have been made as needed, thus improving uniformity.

In going to automatic control it was necessary to design a system which would make all observations and decisions, and perform the same functions as the operator. The new controller



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consists of a control console, working in conjunction with the previously installed beta-ray gages (at right in Fig. 2), plus a motor-gear box for adjusting each end of the calender roll.

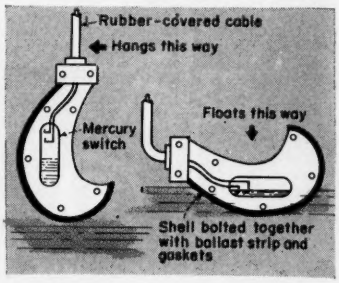
A potentiometer was added to the gage equipment which produces a voltage proportional to the percentage of resin in the treated paper. This voltage is filtered, sampled, stored and selected as a function of whether one- or two-web operation is in process, and whether the desired control is to the upper or lower limit. It is then subtracted from an adjustable reference voltage which is set to the desired resin content. The resultant error voltage is the input to a departure-position servo system which corrects the desired end of the calender. That is, the error signal calls for a given change in position but not an absolute location.

To do this a differential potentiometer is used for the position follow-up. The calender positioning motor operates both the calender roll and the arm of this potentiometer to cancel the error voltage. After the correction has been made, a second motor is used to rezero the position feedback potentiometer by switching zero volts in place of the error voltage and servoing the potentiometer body. A separate servo system is provided for each side of the calender roll. Thus, while one side of the calender is being corrected for a previous error measurement, the other side is measuring the resin content error and rezeroing its servo system.

The above describes a two-loop servo system. The inner loop is that of calender roll position, and the outer loop, which involves the beta-ray gages, is that of percentage resin content in the paper.

If the required correction is in the direction to close the calendar rolls, the servo system does this directly. If, however, the rolls must be opened, an additional signal is added to the resin-content error voltage. This additional signal is made slightly greater than the system backlash. When this combined error signal is reduced to zero, at which time the calender has been opened an amount equal to the desired correction plus the system backlash, the backlash signal is switched out. The servo then closes the calender rolls so as to reduce the remaining position-error signal to zero. Thus corrections are always made in the closing direction so as to eliminate the effects of backlash.

There are some other features of the system which add to its usefulness. One of these is an excessive-error alarm which detects process malfunction. Another is a gain control in the resin-content loop of the system. This enables the operator to specify the amount of calender position correction required for a given resin content error. The amount of this correction is dependent upon the type of material being processed. The original manufacturing process was not altered or interrupted with the installation of this automatic controller.



Float Switch Tips for Level Alarm

Massimo Rosicarelli
Engineer, Torviscosa-Udine, Italy

It is often necessary to install a level alarm in various sorts of process and storage vessels. The common types of level alarm usually require major modification in the structure, and often their operation is not entirely dependable on account of sticking through corrosion of the hinge or pivot points.

The sketch shows a standard type of level alarm which we have constructed for use in any type of vessel, open or closed. The device consists of two shells which can be molded of plastic, carved out of wood, or pressed from metal. These are bolted together with a piece of heavy metal—lead or stainless steel—gasketed between the flanges of the shells, to act as ballast and cause the assembly to float in the position shown in the righthand sketch.

Inside the cavity formed by the shells is a mercury switch held in place by two rubber cushions. A rubber-covered cable carries current to the switch and also acts as a suspension wire to support the device.

When the level is low the device hangs vertically and the switch contact is broken, as in the lefthand sketch. As the level rises, the device floats, tipping into a horizontal position and making contact, as shown in the sketch at the right.

★ Winner of February Contest—Robert K. Multer

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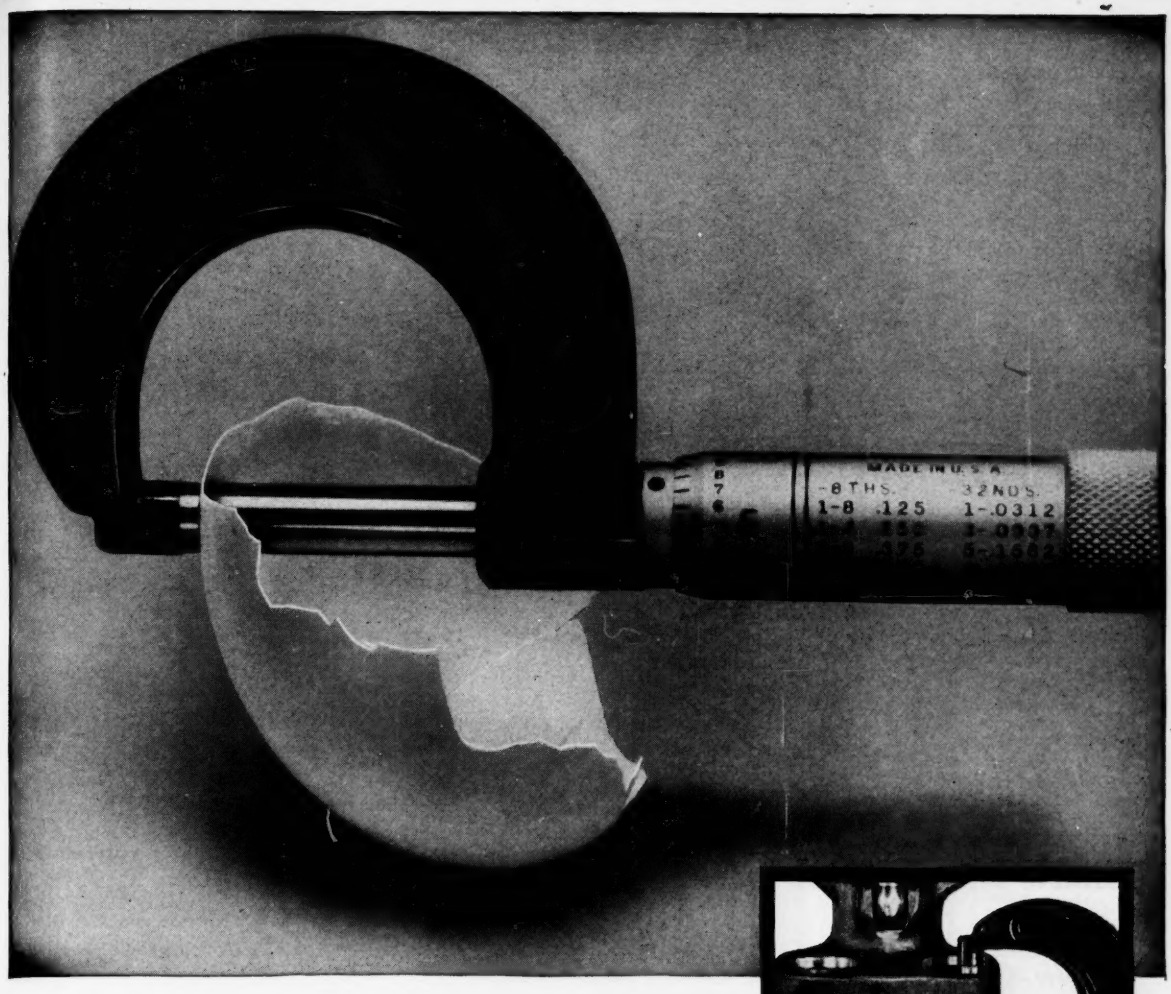

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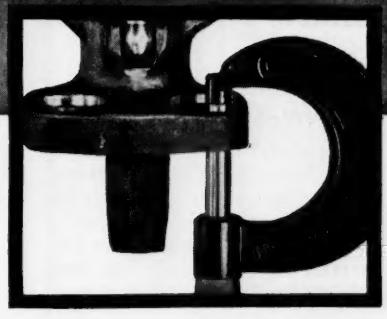
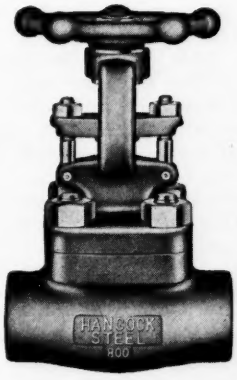
that matches the purpose





THE BONNET FLANGES on the Type 950 Hancock Steel Gate Valve combine compactness with rugged strength *where strength is needed most.* Flange thickness and bolting provide sturdiness that can withstand more than ten times the rated pressure of the valve. Butting of the flange faces eliminates every possibility of bending and distortion.

In revalving old, or installing new process and power piping systems, the enduring strength of Type 950 Hancock Steel Gate Valves always proves there is no substitute for the economy of quality. Get complete facts. Phone your Industrial Supply Distributor today.

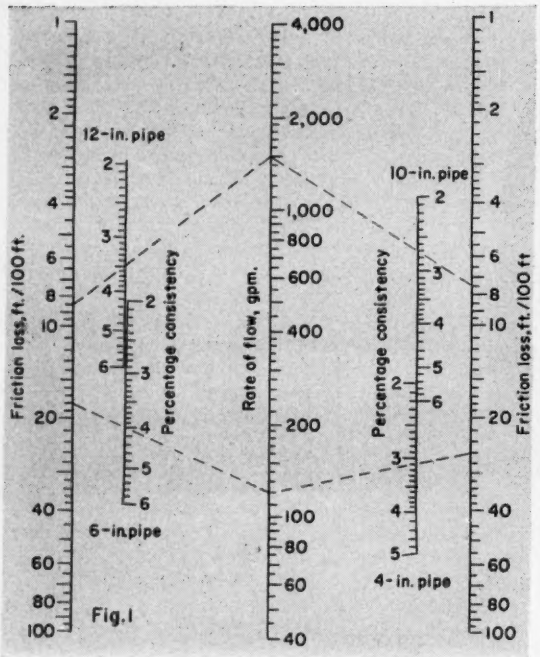
HANCOCK VALVES

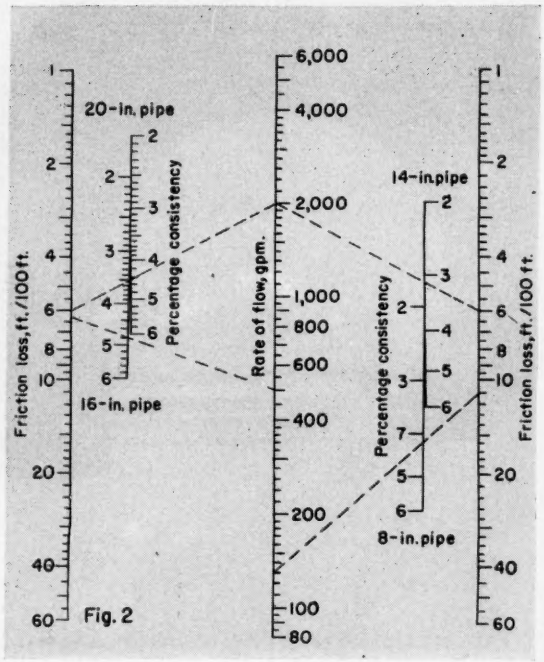
A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*





Charts Give Friction Losses in Paper Stock Suspensions

Dale S. Davis
Professor of Engineering, University of Alabama, Tuscaloosa, Ala.

Data of Brecht and Heller of the Technical College, Darmstadt, Germany, on friction losses in paper stock suspensions have been correlated at the University of Maine. Results were summarized in eight logarithmic family-of-curves plots (E. Schwandt, *Power*, 99, 124, Oct. 1955). The data deal with flow of unbleached sulfite, kraft, and cooked groundwood in Sched.-40 steel pipe, but are valid for all usual pipe materials, although friction losses in cement-asbestos pipe may be lower than the values that appear in these plots.

To obviate inconvenient interpolation between lines of constant consistency and facilitate accurate reading, the information contained in these eight plots is presented in the nomographs of Figs. 1 and 2, which were constructed through application of standard methods described in texts.

Friction losses for unbleached sulfite, kraft, and cooked groundwood can be read directly from the nomographs. For soda, bleached sulfite, and reclaimed paper stocks, friction losses from the charts should be diminished by 10%; for groundwood such losses should be increased by 40%.

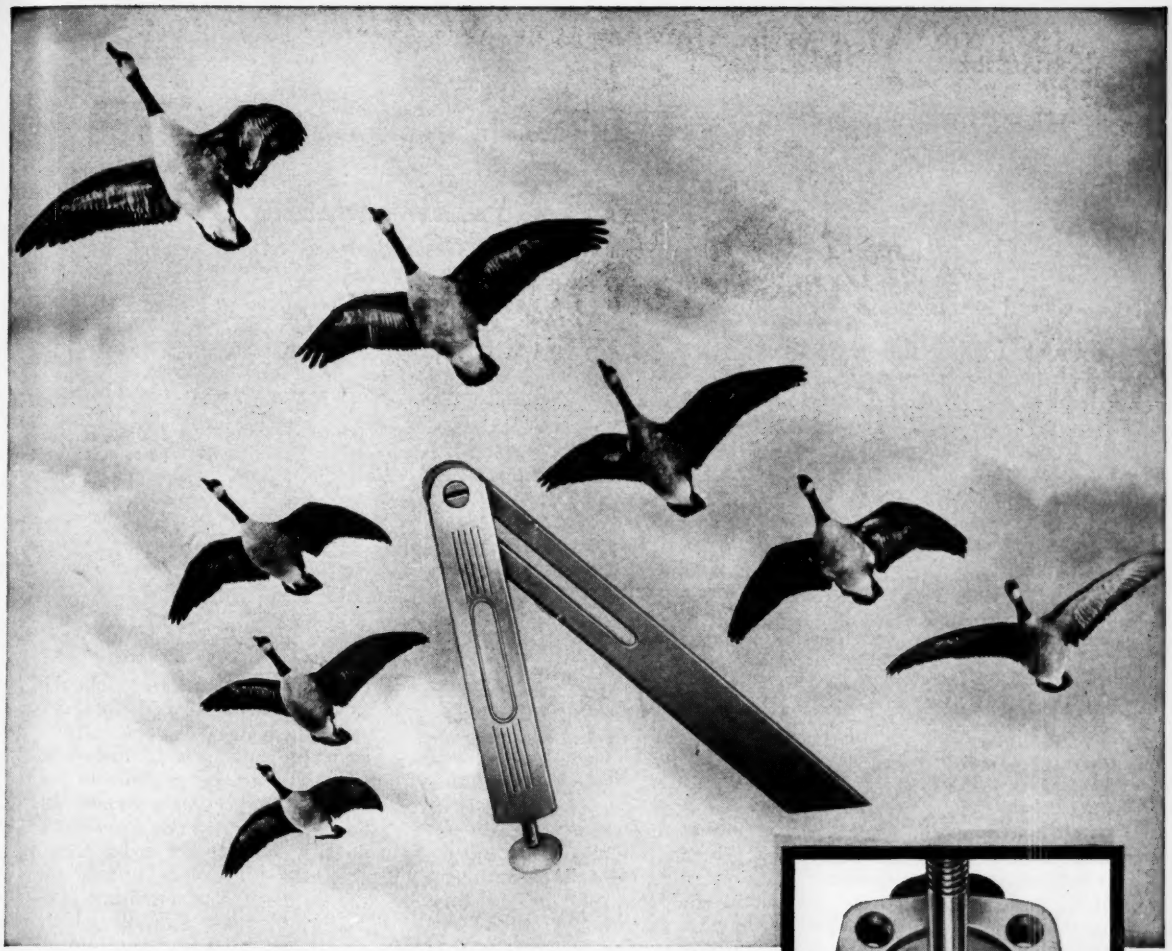
Note that each chart bears two scales for friction losses—one at the right and one at the left. They are used with a common central scale for rate of flow. Each half of each chart bears two scales for percentage consistency. These apply to pipe sizes that are given above or below the scales. Pipe sizes range from 4 to 20 in.

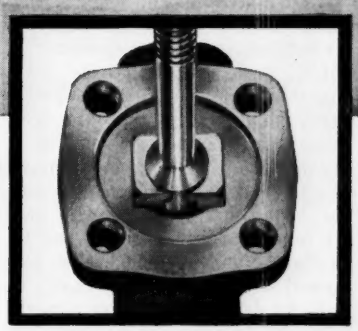
The table lists consistent values of the variables read at the intersection of the broken index lines with the various scales and thus serves to illustrate the use of the nomographs.

Employ the usual friction loss charts for water when consistencies are less than 2%. For consistencies between 2 and 3% use the nomographs only when the linear rates of flow are below 10 ft./sec. Use the charts for consistencies in excess of 3% only when the linear rates of flow are less than 8 ft./sec.

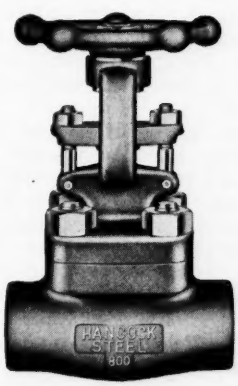
These Examples Show How to Use the Nomographs

Figure	Location	Nominal Pipe Diameter, In.	Rate of Flow, Gpm.	Percentage Consistency	Friction Loss, Ft./100 Ft.
1	Right	4	120	3.1	26
1	Right	10	1,500	2.7	7.5
1	Left	6	120	4.0	18
1	Left	12	1,500	3.5	8.5
2	Right	8	130	4.2	11
2	Right	14	2,000	3.1	6
2	Left	16	500	4.8	6.3
2	Left	20	2,000	4.5	6.0





GUIDE-ABILITY
that means longer life



FULL GUIDING in the Type 950 Hancock Steel Gate Valve does not permit the wedge to gall, scuff, chip or wear the seating surfaces. Four accurately-machined grooves in the valve body guide the wedge to and from the seats and prevent wedge rotation. No matter how great the flow and pressure load or the rotating force exerted by turning the handwheel, the wedge corners do not hit or rub across the seating surfaces. This close-clearance guiding protects against seat damage that frequently causes other valves to leak in as few as one opening-and-closing operation at service pressures.

The provision for precise *full guiding* adheres to the principle that valve seats and wedges *should wear from long service, not from battering against each other.* It is one of many quality features that keep Type 950 Hancock Steel Gate Valves in the line longer. Your Industrial Supply Distributor will gladly demonstrate. Phone him today.

HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

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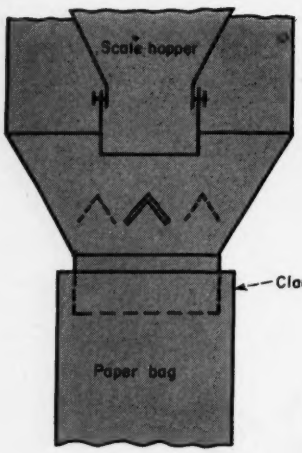


Fig. 1

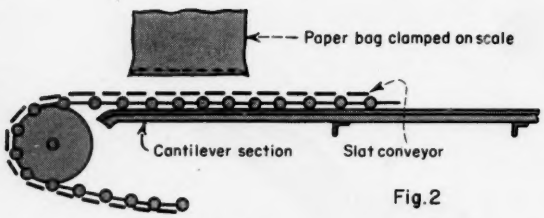


Fig. 2

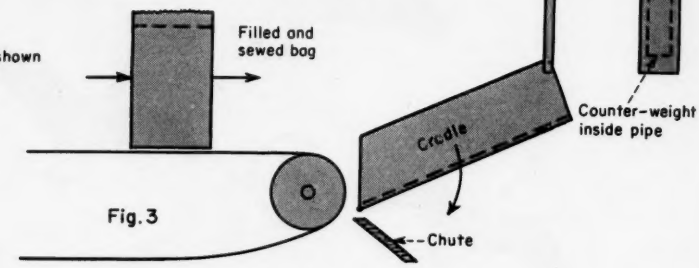


Fig. 3

Cutting Costs With Multiwall Bags

Chesman A. Lee
Engineer, Evanson, Ill.

When a product is shipped the year around in paper bags, it is ordinarily easy to design the filling line to eliminate bag breakage. However, some products such as fertilizer are seasonal and have to go out in a rush. Then the equipment must be rugged so as not to get out of order during the rush; and it must be simple so as not to suffer between seasons when exposed to the corrosive dust. It has to pay for itself on a part-time basis. Consequently, rather high bag breakage is tolerated. But any reduction in breakage is well worth while.

We can list some of the causes of breakage, along with steps to offset them:

• In the case of net-weighing scales, the pre-weighed batch drops into the clamped-on bag above the sewing conveyor. Impact tears the top of the bag.

It is obvious that an 80- or 100-lb. slug of material falling perhaps 3 ft. into the bag will stop with a jolt. First I tried a cradle under the bag, but it was too tricky. I got a better idea, shown in Fig. 1. Three vees were installed, but the outer ones, shown dotted, gave trouble with some materials and were removed, leaving the single one at the center. This inverted vee was completely successful in retarding the fall, permitting us to go from four-ply to three-ply bags for the 100-lb. load. However, the material was not fertilizer.

• Bulking varies with different formulas, so several different lengths of bag are required. If the scale is at the proper height for a long bag, then it will give too long a drop for a short bag used for denser material.

Granular material settles rather solidly in a bag, even when being gross-weighed. There is little "give" to take the impact on the conveyor. So we built some "give" into the supporting frame of the conveyor, as in Fig. 2. The conveyor here is of the slat type, carried on Link-Belt type MR roller chain. The track was simply cantilevered for a few feet under the scale.

• Sewing machines may give trouble.

Valve bags save sewing machine trouble. With 80-lb. bags they save about 25 c./ton in direct labor, but cost about 25 c./ton more. Good servicing helps sewing machines a lot. Also, when they are in use in freezing weather, they should be kept warm. It is helpful to store them in large cans of thin oil while waiting to be installed.

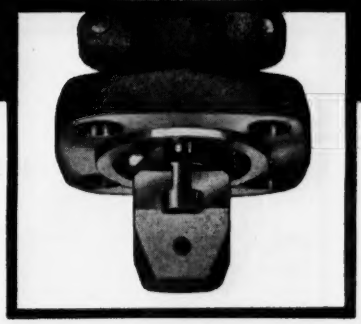
• There are arguments in favor of bagging on a mezzanine floor, and sliding the filled bags down a chute to the dock. However, the chute velocity may be too high for easy handling.

Fig. 3 shows a cradle which eliminated trouble at the foot of the chute.

• Handling the filled bags may give trouble. If they won't stack well, they may fall off the truck when towed in a "trackless train." And impact may be too high when bags are tossed into the customer's truck.

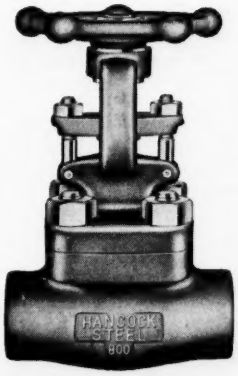
Trouble in this category usually comes from using bags that are too short. You can make a direct saving of, say, 15 c./ton by using shorter bags and filling them plump, but this is a costly saving. Plump bags don't stack well, and also burst easily when dropped.

A series of tests showed that a loosely filled bag could be dropped 3 ft. repeatedly, without breaking. But as the test bags were sewed tighter and tighter, they withstood less impact. One sewed directly above the level of the material burst with one drop. Loosely filled bags need to be flattened before stacking, but then handle easily in stocking, re-handling and loading. Sometimes a lighter weight of paper can be used.



STAMINA

that takes heavy loading



THE STEM-WEDGE CONNECTION in Type 950 Hancock Steel Gate Valve won't bend or fracture even if corrosion prevents opening the valve. So strong is the connection that destructive "cheater" loading on the handwheel will first break the stem thread. The operator thus knows that the valve is still closed and can act to safeguard equipment and avoid shutdowns.

This ultra-strong stem-wedge connection, *an exclusive Hancock design,* overcomes a structural weakness widely recognized in other small gate valves. Its balanced design also places the "T" head slot in the wedge so that the stem can move freely, even though flow forces the wedge against the guides. It is a powerful example of the quality that makes Type 950 Hancock Steel Gate Valves perform better and longer in the severest services. Call your Industrial Supply Distributor for full details today.

HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

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CE Flow File—IV

This month's addition to your continuing series: The last four formulas for water.

Maxey Brooke, Chemical Engineer, Old Ocean, Tex. (For author biography see *Chem. Eng.*, Jan. 1957, p. 298.)

12. Water

APPLICATION

Pressure drop due to a gradual enlargement of cross-section in pipes.

NOMENCLATURE

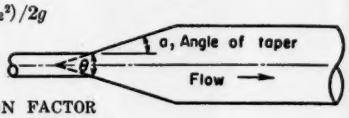
H = Head loss, ft. water.
f = Friction factor.
V_1 = Velocity in small section, fps.
V_2 = Velocity in large section, fps.
g = 32.2 ft./sec.^{2}
θ = Twice the angle of taper.

REFERENCE

H. W. King and E. F. Brater, "Handbook of Hydraulics," 4th. Ed. p. 6–16, McGraw-Hill Book Co., New York (1954).

FORMULA

$$H = f(V_1^2 - V_2^2)/2g$$



TO FIND FRICTION FACTOR

θ, Deg.	f	θ, Deg.	f	θ, Deg.	f
2	0.033	10	0.078	35	0.55
4	0.039	11	0.090	40	0.60
5	0.042	12	0.100	45	0.64
6	0.046	15	0.16	50	0.67
7	0.050	20	0.31	60	0.72
8	0.055	25	0.40	75	0.72
9	0.066	30	0.49	90	0.67

13. Water

APPLICATION

Flow of water over sharp edged V-notch weirs.

FORMULAS

$$W = 156\ (\tan a/2)^{0.996}\ H^{2.47}$$
$$Q = 2.505\ (\tan a/2)^{0.996}\ H^{2.47}$$

NOMENCLATURE

W = Flow, lb./sec.
Q = Flow, cfs.
a = Vertical angle of notch.
H = Head above vertex, ft.

NOTES

For liquids other than water, Perry suggests multiplying the flow by $(m/s)^{0.02}$
m = Viscosity, centipoise.
s = Specific gravity (water at 60F = 1.0)

LIMITATIONS

Angles from 25° to 118°

REFERENCES

F. W. Greve, *Eng. News-Record* **105**, p. 166 (1930)
J. H. Perry, "Chemical Engineers Handbook," 2nd Ed. McGraw-Hill Book Co., New York (1941).

14. Water

APPLICATION

Flow of water through a Parshall flume

FORMULA

$Q = 4WH^x$ where $x = 1.522W^{0.026}$

NOMENCLATURE

Q = Flow, cfs.
W = Width, ft.
H = Upstream head, ft.

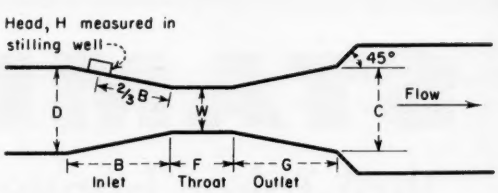
DIMENSIONS FOR BUILDING PARSHALL FLUMES

When width of throat W is 3–9 in.

W	B	C	D	F	G	K	N
3	18	7	10 3/16	6	12	1	2 1/4
6	24	15 1/2	15 1/2	12	24	3	4 1/2
9	34	15	34 5/8	12	18	3	4 1/2

REFERENCE

"API Manual on Disposal of Refinery Wastes," 4th Ed,. 1949, p. 77.



When width of throat is over 9 in.

$B = 0.49W + 47$
$C = W + 12$
$D = 1.196W + 18.84$
$F = 24$
$K = 3$
$G = 36$
$N = 9$

15. Water

APPLICATION

Flow of water over sharp crested rectangular weirs.

FORMULA

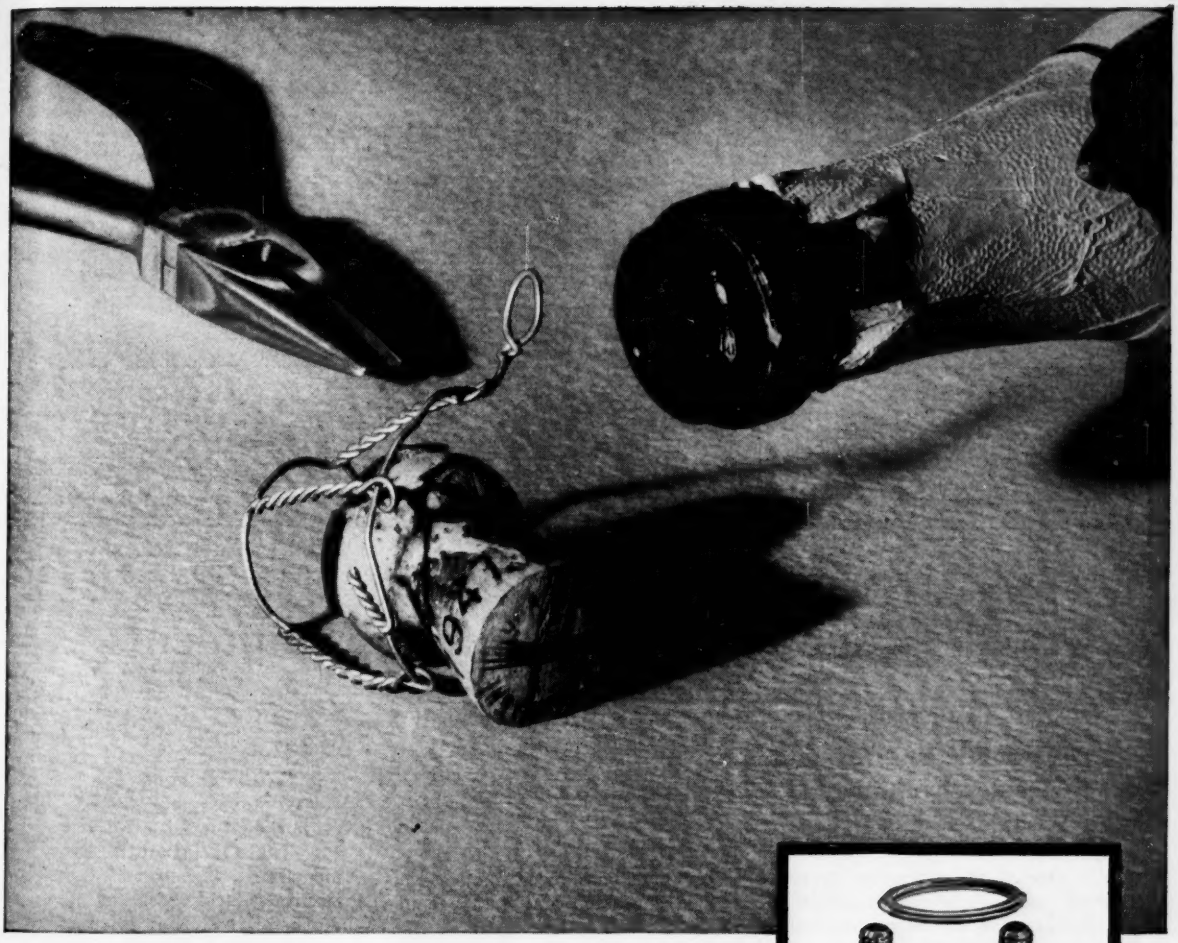
$$Q = 3.34LH^{1.47}\ (1 + 0.56\ H^2/D^2)$$

NOMENCLATURE

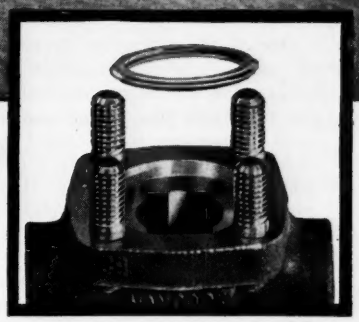
Q = Discharge, cfs.
L = Length of weir crest, ft.
H = Head on weir, ft.
D = Depth of water upstream from weir, ft.

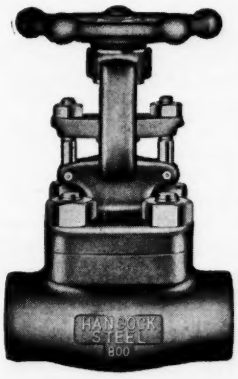
REFERENCE

H. W. King, "Handbook of Hydraulics," 3rd Ed. McGraw-Hill Book Co., New York (1939).



SEAL-ABILITY
that prevents blowouts





THE FLEXITALLIC GASKET creates a positive, pressure-tight seal in the bonnet joint of the Type 950 Hancock Steel Gate Valve. It is a spiral-wound ribbon of stainless steel with asbestos filler and spring-like compressibility. The gasket can be reused – cannot be flattened as the flanges which retain it form an integral compression gauge. Because the gasket rests in a groove in the body flange, it cannot blow out *even if pressures exceed ten times the rating of the valve.*

Only a specially-designed bonnet joint can fully utilize the tremendous sealing power of the Flexitallic gasket. Advanced engineering of the Type 950 Hancock Gate Valve proves that an investment in quality pays dividends in trouble-free performance. Let your nearby Industrial Supply Distributor explain fully. Phone him today.

HANCOCK VALVES

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Painting Is Not Always the Cheapest Method—Table I

Steel Costs ($/Lb.)	Cost of Increasing Steel Thickness ($/Sq. Ft.)	Painting Costs ($/Sq. Ft.)
0.50	0.80	0.32 to 0.44
0.40	0.64	0.32 to 0.44
0.30	0.48	0.32 to 0.44
0.25	0.40	0.32 to 0.44
0.20	0.32	0.32 to 0.44
0.15	0.24	0.32 to 0.44
0.10	0.16	0.32 to 0.44

At 25¢/lb. or less . . . it may not pay to paint steel

Costs based on 20-year period

Update Your Ideas on Painting Equipment

Proper use of paint can save you much money and trouble in protecting steel equipment. Here is how to decide when to paint and what paint to use.

J. Bigos, Mellon Institute of Industrial Research, Pittsburgh, Pa.

One of the attractive features of using organic coatings or paints for corrosion control is the relatively low initial capital cost. However, paint must be used correctly. And many people don't realize that while these costs are low, they may still be too high for the protection they afford.

Most painting is a compromise from the ideal of no painting. Of course, one way to get around the cost of painting is to eliminate it completely. Some opportunities for this exist in chemical plants.

Glass block or translucent plastic sheets can be used. Concrete floors can be finished in colored cement. Wall painting can be eliminated by using glazed construction tile. In processing areas ceramic tile or alloy metals can eliminate painting of plant equipment.

Often it is more economical to let steel rust, rather than paint. By adding an increase in thickness as a corrosion allowance to the original design requirement, any desired length of life may be achieved. However, a pitting factor must be allowed due to localized corrosion which may cause failure at a pit or notch.

Low Painting Costs

In Table I the cost of increasing steel thickness for an industrial atmosphere (using a pitting factor of 4 to 1) is compared vs. painting costs for different "in place" costs of steel. For fabricated and erected steel which costs as much as $0.20 to $0.25/lb. it is about as cheap to paint as to add a corrosion allowance.

How Costs Are Calculated

Radecke[1] shows that a typical tank can be painted for 12.2 c./sq.ft.—sandblasting and applying four coats of paint. Allowing a generous allowance for overhead costs, this figure becomes 16 c./sq.ft. Life of the paint job is seven years. Repainting—spot clean, spot prime, two finish coats—costs 8 c./sq.ft. with overhead. Life expectancy is seven years. Total painting cost for 20 years is 32 c./sq.ft.

Steel Structures Painting Council[2] estimates cost of original painting at 24 c./sq.ft. if done by contract. Life expectancy is seven years. Repainting by contract will be 10 c./sq.ft. Total painting costs will be 44 c./sq.ft.

Of course, the cost of capital, and lost profit because of increased investment, must be considered. If we figure the cost of capital investment at 5% per year, then the situation changes (see Table II). Painting- investment cost is spread over the twenty years. Steel as low as $0.15/lb. can be economically protected by paint.

Painting Schemes

To get minimum maintenance paint cost, it's advisable to push the annual painting cost/sq. ft. of surface to a minimum through proper surface preparation, proper paint application and paint selection. Real cost of painting is cost/sq. ft. divided by the years of service between repaintings.

In some plants, out-of-face painting works best. In this scheme you repaint everything in a given area. Some items will be past due for painting and some will be repainted too soon.

Complete repaint may take place while the plant is shut down or on vacation. The reduction in painting cost achieved by concentrated effort may offset any losses by painting too late or too soon. Same plants use this procedure because of necessity.

It may be impossible to paint during normal working operations because of safety condi-

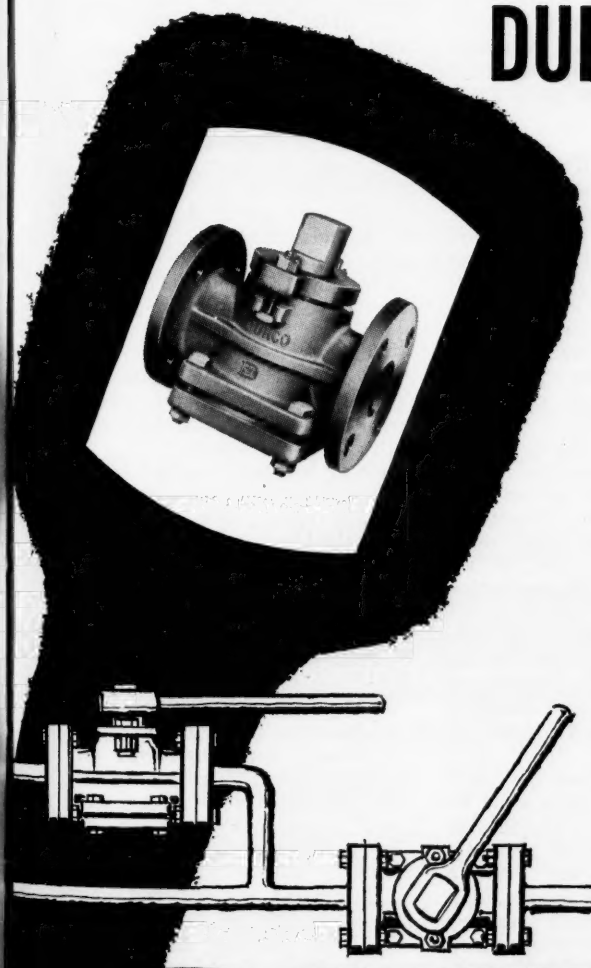
"the answer..."

at Hercules Powder Company

HERCULES, CALIFORNIA

may be the one you've been looking for!

DURCO type F valves



For handling fuming red nitric acid, Durco Type F Valves have proved to be THE answer for Hercules.

On the manifold pictured above, there are nineteen Durco Type F Valves. These Durimet 20 valves have been in service more than three years . . . that is *trouble-free* service for more than three years. The pump is a D3RD Durcopump.

Hercules Powder Company is a leading producer of acids, anhydrous ammonia, and other ammonia products, cellulose products, resins, terpene chemicals, rosin and rosin derivatives, chlorinated products, industrial explosives, and many other materials. Since first using this type valve in their Hercules, California plant early in 1952, this Hercules plant has placed more than thirty repeat orders, in varying quantities, for Durco Type F Valves.

There are thousands of Durco Type F Valves in hundreds of applications, and we do not know of a single dissatisfied user.

Maybe we can solve a tough problem for you.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC., Dayton, Ohio

Branch Offices: Atlanta • Baltimore • Boston • Buffalo • Chicago • Cleveland • Detroit • Houston • Knoxville • Los Angeles • New York • Philadelphia and Pittsburgh

XUM

Comparing Painting and Steel Thickness Costs Over 20 Years—Table II

Cost of Steel	Cost of Increasing Steel Thickness			Cost of Painting		
($/Lb.)	Steel ($/Sq. Ft.)	Interest ($/Sq. Ft.)	Total ($/Sq. Ft.)	Painting ($/Sq. Ft.)	Interest ($/Sq. Ft.)	Total ($/Sq. Ft.)
0.50	0.80	0.80	1.60	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.40	0.64	0.64	1.28	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.30	0.48	0.48	0.96	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.25	0.40	0.40	0.80	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.20	0.32	0.32	0.64	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.15	0.24	0.24	0.48	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77
0.10	0.16	0.16	0.32	0.32 to 0.44	0.24 to 0.33	0.56 to 0.77

tions or possibility of product contamination. Sparks from cleaning tools may ignite flammable mixtures.

The key to economical out-of-face painting lies in adjusting the repaint systems to local conditions.

Another method of painting is to coat when necessary. Here, the critical factor in deciding when and how to repaint is whether painting is primarily for protection or for appearance.

The basic philosophies of painting are different for these two. It is axiomatic, in painting for protection, that maximum dry thickness of paint or coating be achieved.

All other factors being equal, the protection afforded by a coating is proportional to its thickness. Get-ready, surface preparation, scaffolding, and such items are a fixed amount for a job. Increasing the number of coats of paint adds a minor increase to the total cost—not an increase directly proportional to the number of coats.

Painters should achieve the minimum coverage in square feet per gallon of paint, rather than stretching out paint. The painting procedure should be adjusted so that repainting takes place when natural erosion thins the dry paint thickness. This prevents excessive buildup of paint with subsequent loss of adhesion and flaking.

Decorative painting strives to achieve maximum appearance at minimum cost. Repainting is usually dictated by poor appearance caused by soiling, loss of gloss, mildew or other factors which are not a function of dry paint thickness.

Here economy dictates the advisability of painting with minimum dry film thickness. Paint cost is reduced by getting the maximum coverage in square feet per gallon that is consistent with satisfactory appearance—and durability when paint durability is a factor.

Preparing Metal Surface

It is imperative that rust be removed down to sound metal before painting (see Table III). If primers with good wetting power are used, it is possible to paint over the slight residues of rust (that are almost impossible to remove by methods short of blast cleaning or pickling). These are without exception, slow drying primers.

Weathering of steel to remove mill scale should be followed by sandblasting. This procedure—covered by Steel Structures Painting Council Surface Preparation Specification No. 9—results in good surface preparation at moderate cost.

Weathering followed by wire brushing leaves considerable rust on the steel and the Steel Structure Painting Council considers this a poor method of surface preparation.

Any anchor pattern produced by surface preparation must be conducive to good paint adhesion and bonding. Solvent cleaning, improperly done, may leave a residue of oil and grease in a thin film over the entire surface.

Also, excessive power wire brushing may burnish the surface, particularly in the case of mill scale, to the point where paint cannot properly adhere to the surface. Power tools, such as rotary descalers, chipping hammers, and scalers, may leave sharp ridges in the metal surface which cannot be adequately coated with paint. The same danger exists when blast cleaning with large abrasives.

Pickling operations may leave residues of hydrochloric or sulfuric acid on the metal surface unless properly rinsed. These residues of free acid will react with the metal to form sulfates and chlorides, and the residual salts are strong stimulators of corrosion.

Pretreating Methods

Closely coupled with surface preparation are pretreatments used to further reduce the possibility of paint failure.

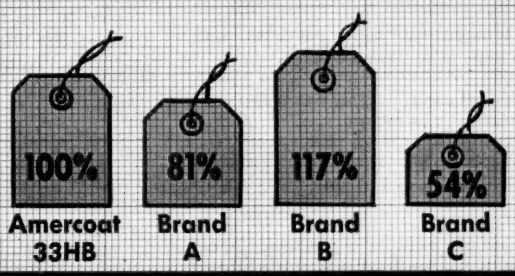
Cold phosphate and hot phosphate treatments are used to convert clean, rust and scale-free steel surfaces to insoluble, crystalline layers of iron, and zinc phosphate. The resulting phosphate has increased corrosion resistance because of its relative inertness and high electrical resistance.

These crystalline-surface conversion coatings also improve paint performance by forming a good surface anchor for the coating (the surface is uniform and local corrosion through dissimilar surface conditions is minimized).

Galvanized iron and steel show frequent paint failure. This failure is due to poor adhesion of paint. Although a host of nostrums and home cures have been

YOU CAN'T KNOW
what the real price tag is...

How price per gallon compares on leading vinyls



UNLESS YOU
compare mil sq. ft. per gallon and...

Sq. ft. coverage per gallon, 1 mil thick

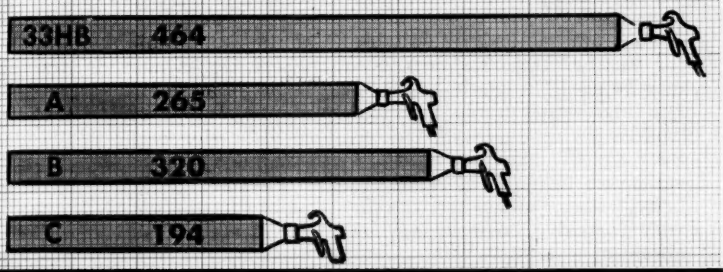
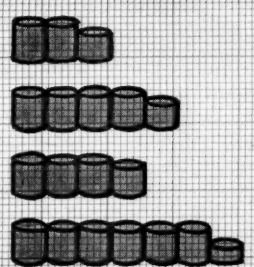


FIGURE THE
material cost of each coating, then get the...

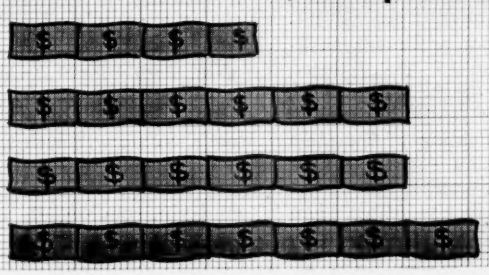
Needed to coat 250 sq. ft. 5 mils thick



	GALS.	COST
33HB	2.68	$17.37
A	4.72	24.78
B	3.91	29.72
C	6.44	22.54

REAL COST
by adding labor for the number of coats needed.

Labor & material cost, 250 sq. ft. x 5 mils thick



33HB	$37.47
A	60.18
B	59.05
C	70.84

Announcing...

A True High Build Vinyl Coating

Amercoat 33HB now gives you even *more* "mils per gallon" —and at the lowest cost of any leading vinyl!

At last, the two major limitations of vinyl protective coatings—critical adhesion and low film thickness—have been largely overcome. Amercoat 86 Primer stopped adhesion troubles, eliminated underfilm corrosion and undercutting, and simplified surface preparation. *Now Amercoat 33HB Topcoat builds thick films in fewer coats at surprising savings.*

Amercoat 33HB is a "high-build" version of Amercoat 33, the standard of the protective coatings industry for over ten years. 33HB gives you the same high resistance to corrosive chemicals, severe weathering and abrasion, *plus 33% greater thickness per coat!*

The solids content of 33HB tops all other non-mastic vinyl coatings, yet workable viscosity is retained. It applies smoothly and easily by hot or cold spray. No need to stock two types of materials.

New Lower Cost

In evaluating any coating, always look at the cost per square foot, and the number of coats required to build proper film thickness. 33HB is nearly 24% cheaper per mil square foot than traditionally low cost 33...and compared to other leading vinyls, (see chart) savings are even greater. For example, although the gallon price of Coating "C" is 46% lower than 33HB, because of its low solids content the actual *material* cost for 5 mils thickness is almost 30% higher than 33HB, and the applied cost, (labor and material) is almost 90% higher.

For the full story, send coupon for data on 33HB and detailed cost comparison of the four coatings on the chart.

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Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Consider These Factors When Repainting Steel—Table III

Condition	Cleaning and Painting Recommended
No rusting	Solvent clean if necessary. Apply one or two coats of finish paint depending upon conditions.
Slight rusting in localized areas.	Spot clean and spot prime. Apply one or two over-all coats of finish paint as necessary.
25% to 50% exposed area in localized areas.	Spot clean and spot prime. Apply one over-all coat of priming paint and one or two coats of finish paint as necessary.
Over 50% exposed area.	Remove as much old paint as is practical. Apply two priming coats and one finish coat, or one priming coat and two finish coats as necessary.

advanced as pretreatments for galvanizing, practically none of these have merit and many of them are dangerous as they cause destruction of the zinc. However the phosphate pretreatments convert the surface of galvanizing to a satisfactory paint anchor.

Wash-primer pretreatment is another effective method of improving adhesion of paint to galvanized metal. The only conventional paints which have shown merit in painting over new galvanized metal without pretreatment are the zinc-dust pigmented primers. If pretreatment is not feasible and the zinc-dust primers are not used, galvanizing must be weathered for periods of at least six months prior to painting.

Again, as in the case of blast cleaning or pickling, the advantage to be obtained in the use of these pretreatments must be weighed against the increase in cost. For mild atmospheric exposure conditions, where ordinary cleaning and painting methods have proved feasible, it is difficult to economically justify the increased expense.

Selecting Proper Paints

Selection of specific paints for specific purposes obviously depends upon particular plant conditions. The following general guide summarizes current thinking for steel structures, incidental steel work, and steel equipment.

Oil Base Paint—Systems with vehicles which are oil base materials or contain significant quantities of free oil are intended primarily for structural steel exposed to atmospheric conditions.

They are particularly suitable for weather exposure, but they may be used for the interiors of buildings which are subjected to moderately corrosive conditions. Such systems have only limited resistance to chemical exposure, brine, high humidity, burial, very corrosive environment, or abrasion.

Complete removal of mill scale or rust is not required due to the excellent wetting of the vehicles. But thorough surface preparation is a must for satisfactory service in corrosive environments.

Alkyd Paint—Alkyd paint systems are intended primarily for structural steel exposed to atmospheric conditions; they may be used for infrequent immersion in fresh or salt water, or infrequent exposure condensation.

They are particularly suited for severe weather exposure. But they may also be used in interiors of buildings which are subjected to corrosive conditions such as mild chemical exposure, high humidity or infrequent condensation.

Alkyd paints have only a limited resistance to strongly chemical environments, complete immersion, burial or severe abrasion. Because of the reduced performance of the primers on dirty, oily or rusty steel, blast cleaning or pickling of the steel is the minimum surface preparation for new work.

In maintenance painting, when only small areas need to be cleaned, hand or power tool cleaning may suffice if thoroughly done.

Due to the more resistant nature of the alkyd vehicle, typical industrial plants will maintain better appearance for longer periods than if oil base finish coats are used. Typical structures suitable for these systems include blast furnaces, industrial buildings, chemical plants (yard areas or mild interiors only), interiors of buildings exposed to high humidity (but where there is no continuous condensation), belt conveyors, portable equipment, mechanized equipment, etc.

Alkyd primers are particularly satisfactory where colored high gloss enamel finishes are desired such as on transport equipment, machinery, and where appearance is the primary consideration. Alkyd finish paints to match safety colors and identification colors of standard codes are available.

Phenolic Paints — Phenolic paint systems are used primarily for structural steel immersed in fresh water; or exposed to high humidity with continuous condensation; or steel that is alternately immersed in fresh water and then exposed to the atmosphere.

They are also suitable for moderately severe chemical atmospheres that are neither strongly alkaline or strongly acid.

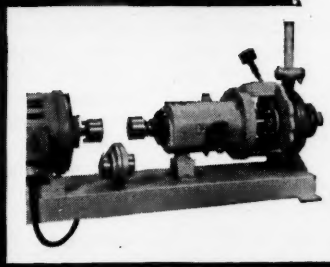
Phenolic paint systems are satisfactory for exposure to brine or salt water if the proper selection of primer and top coat is made. Such systems are satisfactory also for exterior or interior use, but they should be used for the interiors of the building only when subject to corrosive conditions not more severe than already mentioned.

Most phenolic paints have a tendency to wet dirty, oily, rust surfaces poorly; blast cleaning or pickling of steel is the correct method of surface preparation.

In maintenance painting, if only small areas are to be cleaned, careful hand or power tool cleaning will suffice. Typical uses include fresh water vessels and barges, aeration and humidifying equipment, antisweat coatings; interiors of laundries,

3 simple steps to service!

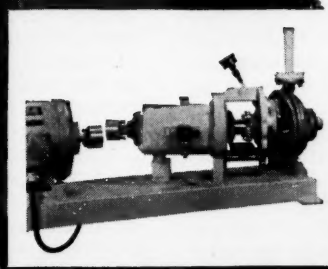
1.



Remove spacer from coupling.

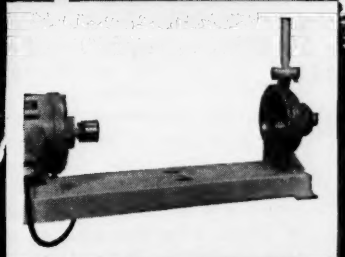
Lower operating and maintenance costs with rugged, dependable, Series H Durcopumps. Simple design and sturdy construction assure long hours of trouble-free pumping. Easy, three-step, one-trade maintenance reduces down time, speeds maintenance, and lowers costs. Series H Durcopumps are available in Durimet 20, the 300 series stainless steels and in eleven other standard alloys for pumping all types of corrosive solutions. A complete range of pump sizes accommodates heads to 350 ft. and capacities to 4500 gpm. Write for details.

2.



Remove cap screws.

3.



Remove the pump. Note: Neither suction or discharge lines are disturbed, nor is motor or alignment affected.

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bottling plants, dairies, beer cellars, ballast tanks, water tanks, sand pipes, docks, etc., where wet conditions prevail.

Chemically Resistant Paints—Paint systems with sufficient resistance to withstand exposure in chemical environments generally include the vinyl, chlorinated rubber, and epoxy materials. Such paint systems are intended for very severe exposures.

One or more are generally satisfactory for most severe atmospheres encountered. They must be used with discretion when service includes complete immersion in corrosive chemicals such as inorganic acids, alkalies and salt solutions; or immersion in solvents such as aliphatics or aromatics, alcohols, oils and grease. These systems are generally dissolved by organic solvents, although many epoxy systems have good resistance to most commonly encountered solvents.

Such systems are recommended highly for immersion in fresh or salt water, exposure to high humidity and continuous condensation or weather exposure. However, upon exposure to mild weather, some of the materials will not have the durability of linseed oil paints. They are particularly suitable for interiors of buildings where flame resistant and mildew proof materials as well as corrosion resistant paints are desired. Because of the great increase in paint life, blast cleaning or pickling of steel is the minimum recommended surface preparation for new work.

In maintenance painting blast cleaning is desirable, but some products are available which can be used over lesser degrees of surface preparation. Due to the great variation in the severity of various chemical exposures, and the varying resistance of synthetic materials such as these, get competent advice before selection of such systems.

Rust Preventive Compounds—Rust preventive compounds which are applied in thick films of about $\frac{1}{8}$ in. are used on steel that requires long time protection in sheltered or inaccessible places, or short term protection in corrosive environments.

These materials are also used where temporary protection is required, such as machined surfaces where the coating will later be removed by solvent action.

Rust preventive compounds are available in varying degrees of hardness. Generally speaking, the harder the material the longer the protection, but the greater the difficulty of removal. Soft films are easily applied by brush or swab at temperatures of 60 F. or above. These are the familiar rust preventive greases. Many of the hard film or pigmented compounds require hot application.

Thick films of these compounds will provide indefinitely long protection in sheltered areas not in contact with strongly corrosive mediums. They will provide only fair protection when exposed to the weather, water or brine. They are used for protection of machinery, machined surfaces, cables, wet or damp steel, particularly in inaccessible places not subject to weather.

Bituminous Coatings—Under the heading of bituminous coatings are included enamels, cold applied mastics, emulsions, and simple cutbacks.

Bituminous systems are available for very severe exposures. They are satisfactory for most severe atmospheres, but they must be used with discretion. They are dissolved by some organic solvents and attacked by some chemicals.

Coal tar enamel is recommended for buried steel. Cold applied bituminous coatings may also be used underground, but with poorer results. Coal tar enamel is also suitable for water immersion, including use with potable water. Bituminous mastics—cutbacks filled with inert material and applied in thick film—are also used under water or in damp environments, but they are not recommended for potable water. They will not have the life that a hot enamel will have under immersion conditions.

Coal tar coatings require a top coat of coal tar emulsion to prevent checking and alligatoring upon exposure to the sunlight. All of these materials are suitable for interior use, but are recommended only for very corrosive interiors.

Coal tar enamel has good abrasion resistance and may be used for coating hopper interiors, exposed to corrosive and abrasive materials such as coal or wet sand. Coal tar enamel is also suitable for marine and hydraulic structures and pipe.

Cold applied asphalt mastic is suitable for general use in corrosive atmospheres. It is particularly good for weather resistance and is used extensively for chemical atmospheres, applied over thoroughly cleaned surfaces and in thick films. Use of thin-film bituminous coatings or cutbacks is not generally recommended for protection.

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1. Radecke, F. T., *Proceedings API*, 34, (III), p. 37 (1954).
2. Bigos, J., Vol. I, II, "Steel Structures Painting Manual," Steel Structures Painting Council, Pittsburgh, (1954 and 1955).

This article is based on a paper delivered at the recent 8th Plant Maintenance & Engineering Conference in Cleveland, Ohio.

New High-Strength Stainless Steel

A new high-strength cast alloy has been developed at Ohio State's department of metallurgical engineering as part of a research program of the Alloy Casting Institute.

Designated as type CD-4MCu, the alloy has the following composition: 25 to 27% Cr, 4.75 to 6.00% Ni, 0.04% C(max.), 1.75 to 2.25% Mo, 2.75 to 3.25% Cu and 1% each Si and Mn(max.).

Corrosion rates of CD-4MCu are of the same order of magnitude as 18-8 stainless.

But tensile strength is 140,000 psi., yield strength is 100,000 psi. and hardness is 300 Brinell. Properties of a comparable 18-8 would be 77,000 psi. tensile, 37,000 psi. yield and 150 Brinell.

New alloy shows no corrosion at room temperature in 10% H_2SO_4, 50% H_2SO_4, or 0.5% HCl. In 5% HCl the corrosion rate is 60 mils/yr.

The new alloy is reported to have better machinability than 18-8 stainless, and good welding, grinding and foundry characteristics.

Chemical Engineering

People

APRIL 1957

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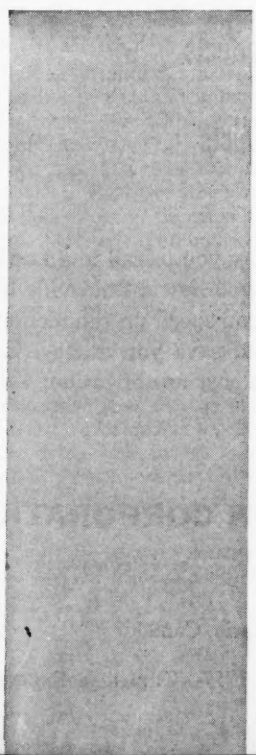

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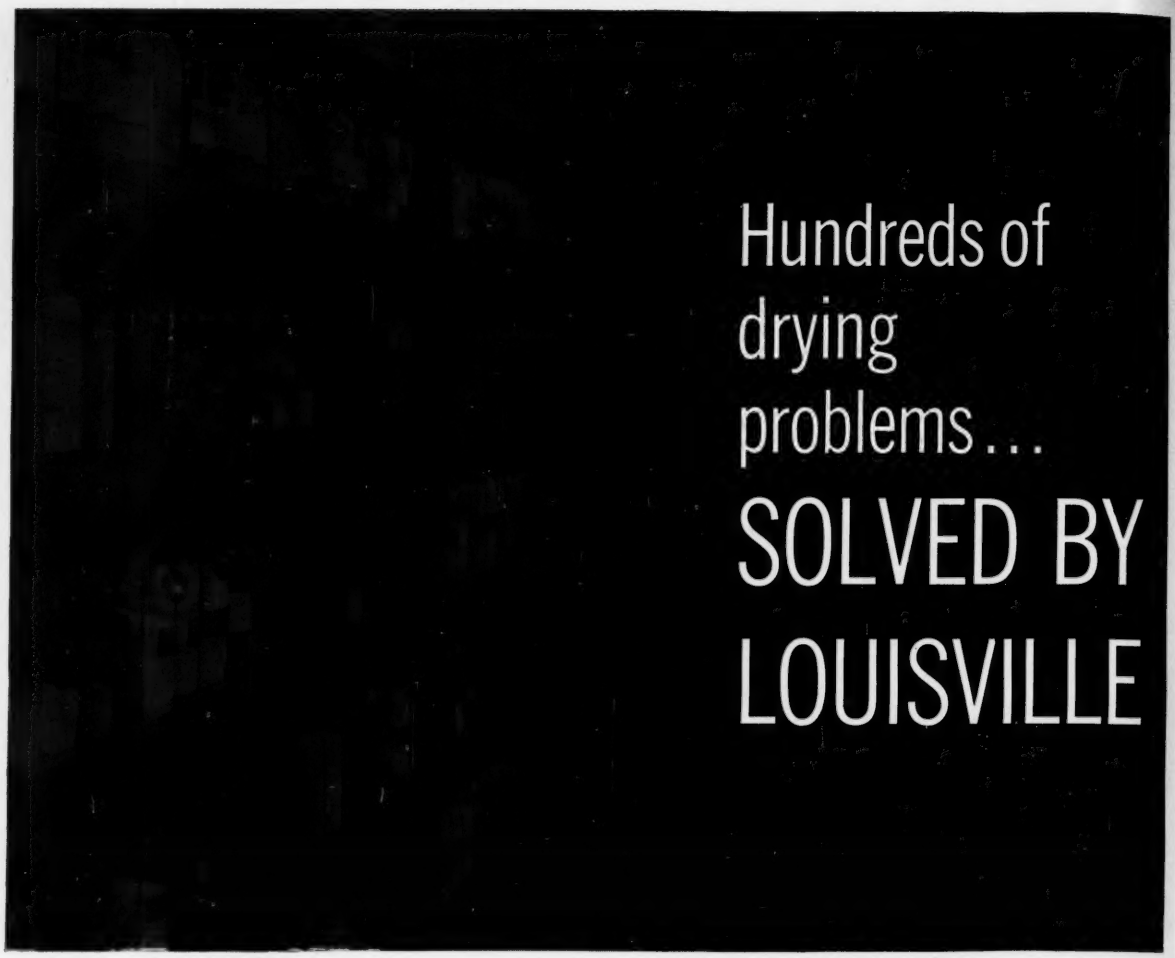

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Let the Editors of 25 Technical Magazines Tell You . . .

How to Get Your Next Article Published

Are you up for promotion or hunting a new job?
Do you want more professional recognition?
Well, what have you published so far? Why isn't the list any longer?

H. C. McDaniel, Director, Technical Information, Westinghouse Electric Corp., Pittsburgh, Pa.*

Next time you apply for a job or are up for promotion someone is going to take a long hard look at your record of technical publications.

Why haven't you published more and what can you do to improve your own record? How can your technical articles increase your professional recognition?

To improve your batting average of acceptance by technical editors, here's what and what not to do. Most of what we have to say is based on information obtained from the editors of 25 leading periodicals that serve the professional needs of as many different industries or occupations (see table on p. 316).

What Is a Technical Article?

Before writing for a technical magazine you should know what the term "technical article" usually means.

As I use it, a technical article is a piece of prose, the basis of which is factual. It aims to inform, instruct, persuade—or a combination of these. It's the result of sustained effort in gathering material, thinking it through (outlining), and writing it down.

It's but one of the communication devices that can be used to transmit information or impart ideas from one mind to other minds. To achieve its objective, the technical article must have a specific purpose and a specific audience.

The Aim of a Magazine

Now that we've defined them, how can we write technical articles that will get published?

How you gather information, how you organize it and how you present it will determine its acceptability to the magazine. But to do this efficiently and successfully, first you must know the aims of the magazine and what it's trying to accomplish editorially. Then you must know who the readers are, and what they do.

Every magazine has a purpose. One editor told me that the purpose of his magazine is "to help industry with its productivity." But we're not dealing with a specific magazine. Rather, we're considering a species: all magazines that publish technical articles.

And, as you might expect, magazines follow the usual pattern of a species in that all members are not exactly alike. In the case of technical magazines, they differ in these two important respects:

- One group is concerned solely with problems of a specific industry or profession and publishes only information of interest and use to that industry or profession.
- The other group is concerned solely with a specific job function such as production, design, maintenance or management.

But regardless of this species distinction, all magazines that publish technical material do it to help the reader do his job better. This is accomplished editorially in one or more of these ways:

- Reporting important new technical information.
- Reporting practical, down-to-earth, how-to-do-it applications of technical information that lead to new or improved methods of operation.
- Reporting new process techniques or technical developments and interpreting the benefits of each.
- Keeping open the lines of communication between members in the industry.

When you write, remember that technical magazines are published solely for the professional needs of their readers. Therefore, the technical editor is interested only in information that satisfies these professional needs.

Who Are the Readers?

Readers of technical magazines are men in business, trade and industry. Every professional occupation is represented: policy and administration; accounting and finance; purchasing and production; research and development; engineering and design; sales and service.

Some of these men have college degrees. Some do not. For those who do, they range from Ph.D. and M.S. to B.S. and B.A. For those who don't, their professional experience is their strength.

Irrespective of the profes-

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* This article is based on remarks before the Conference on Scientific and Technical Writing, Univ. of Pennsylvania, Phila., August 21, 1956.
Meet your author on p. 330.

Rate Your Manuscript

- ✓ Reader value
- ✓ Timeliness
- ✓ Interest range
- ✓ Accuracy
- ✓ Authoritativeness
- ✓ Duplication
- ✓ Completeness
- ✓ Readability

sional needs of a man—or his educational background—there's a magazine that caters to these needs. And this is true regardless of the degree of specialization of his work.

For our purpose, it's not practical to be more specific about readers of technical magazines than that. While we could cite many "for instances," they would serve no useful purpose. More useful is the knowledge that in the business publications rates and data volume of Standard Rate & Data Service, Inc., you can find a numerical distribution of readers by job classifications for each of more than 2,000 such periodicals that serve 125 businesses, trades and industries in the U. S. There's also a numerical distribution of readers by geographical location.

If your public library doesn't have *SR&DS* in its periodical room or at its business branch, you should be able to find a copy in the advertising or public relations department of your own company.

How Articles Are Selected

Though the article you write is aimed at a specific reader, this in itself will not assure publication. The manuscript still has to fulfill the editorial requirements of the magazine and must benefit you as the author. Meeting the editorial requirements usually includes a number of concepts that are almost always headed by the "relevancy" or "reader value" concepts.

Where relevancy is concerned, the editor usually asks: Is it in our field? Is it germane to the industry we serve? Is the material relevant to our editorial program? Or, does the subject matter fall within our editorial scope?

The philosophy of relevance goes about like this: It doesn't do anybody—the reader, the publication, the author or a company—any good to have an article appear where it doesn't reach the greatest number of people interested in the subject and the particular treatment of the subject.

When the manuscript is being tested for reader value, the questions go about like this: Is the subject of interest and value to our readers? Is the material of significance to our readers? Does it give them new, additional or different information about an older subject? How much new, unusual and interesting information does the manuscript contain for our readers? Is the information of immediate practical value? Will it help our readers? Does the article define and/or solve a problem? Will the technique or development be directly useful to our readers?

The last is the key question. Its origin stems from the fact that the technical magazines have built their reputations on the usefulness of their editorial content and today, more than ever, they must adhere relentlessly to this concept.

Timeliness is another concept of great importance. Is it *new?* Does the manuscript describe a new technique or a development of significance to the industry we serve? Does the article deal with a problem of current interest? Is the material fresh, or is it something that's been hashed into a general across-the-board news release? Or, *is* it new or newsworthy?

The underlying thought here is this: Progress is paced by development; development of new materials and machines, processes and techniques. Therefore, if the technical magazine is to serve the professional needs of its readers, it must bring them the latest developments and not something that is already known throughout the industry.

An extremely useful concept at times is interest range. How many readers will be interested? Can the material be presented in a manner that will attract the attention of a fair share of readers? Does the article approach the subject from the angle of greatest interest and usefulness to the reader? Is the subject of broad interest? Will the information be of interest to a wide range of our readers, or is the material too specific for our audience?

Maximum value for the greatest number of readers is the philosophy here. That's usually the basic yardstick used by all magazines. No publication can afford to publish an article that will attract only 3% of its readers when it already has waiting for publication an article that will draw the attention of 75% of its readers.

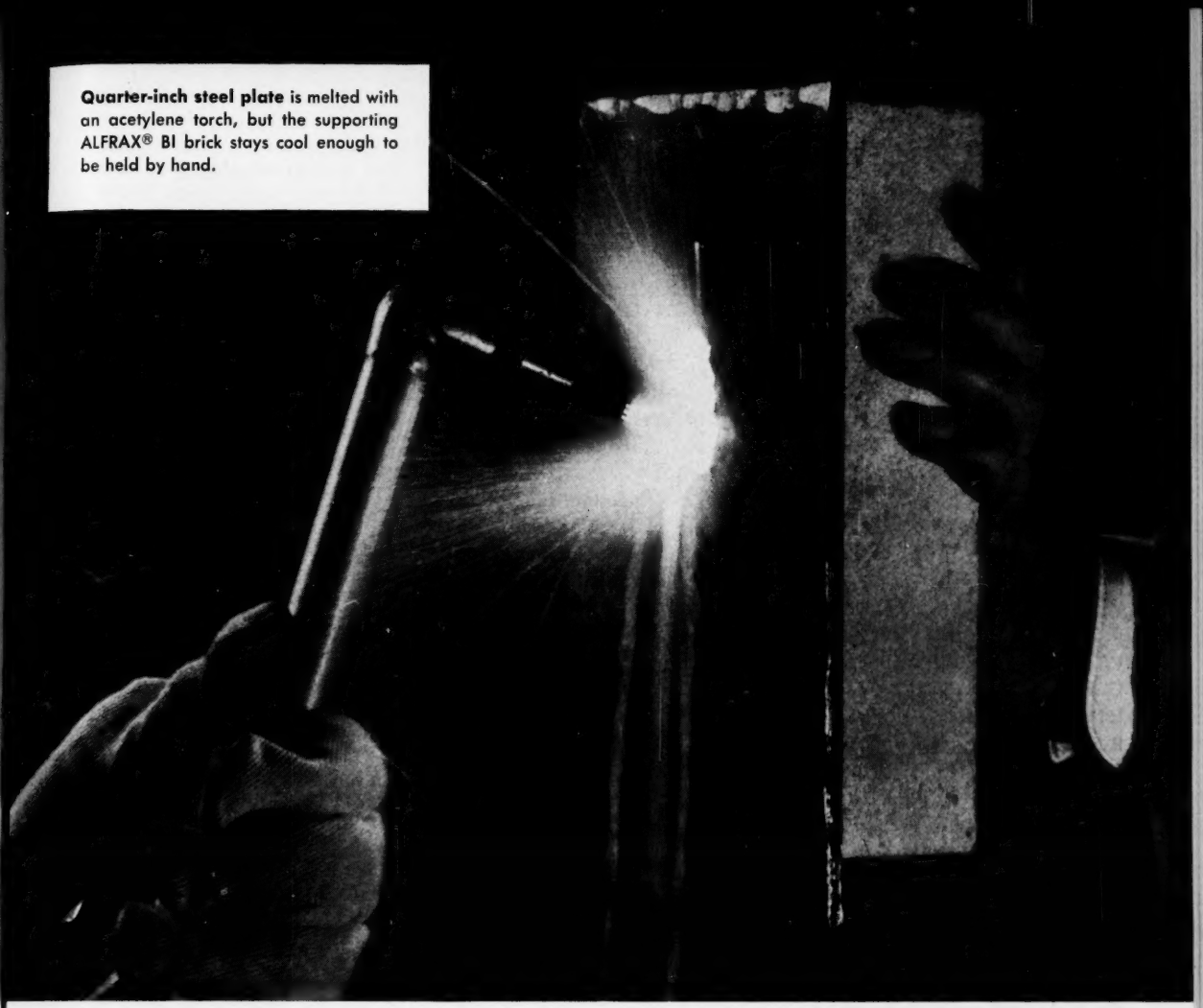
Accuracy is extremely important. Are your statements supported by facts? Is the information accurate? Is the article accurate, factual, impartial? Does the article say something specific?

Technical magazines have a major obligation to their subscribers to make certain that nothing is printed that will mislead them. Claims must be backed by facts. Any unusual statement must be so well explained and supported by facts that the readers will accept its veracity. Readers are interested in facts far more than in claims or generalizations.

In a way, authoritativeness is associated with accuracy. Yet it isn't. Is it authoritative, or is the author an authority in the field he is discussing? This concept is directly related to the line of reasoning that goes something like this: To write intelligently, you must first of all be familiar with your subject. Until you are, the wisest course is to gain experience.

Manuscripts must on occasion be tested for duplication. If this is not a new process or technique, does it add to the literature? Or does it complement or duplicate material recently published or planned for future publication. No editor is going to jeopardize his reputation for being there first-with-the-newest by accepting material that is as old as yesterday's newspaper.

Other things to check for are:



Quarter-inch steel plate is melted with an acetylene torch, but the supporting ALFRAX® BI brick stays cool enough to be held by hand.

Refractories...for really high temperature insulation

The problem of heat insulation at extreme temperatures is solved by two of Carborundum's refractories:

One is made of fused alumina "bubbles" or hollow spheres, bonded and high fired. These selected bubbles give proper balance between the number of surface temperature drops and total pore space (about 65% porosity) to effectively decrease heat flow between hot and cold faces. The alumina imparts high hot strength to the finished refractory, trade-marked ALFRAX BI. Under a load of 12½ psi and a temperature of 2732° F held for 1¾ hrs., less than 1% contraction occurred. No contraction whatever developed in 5 hour reheat tests at 3092° F. This combination of properties makes ALFRAX BI refractories unique in their ability to insulate at temperatures where other materials are impractical.

The other is FIBERFRAX® ceramic fiber, produced by blowing an alumina-silica fusion. Among its properties are high insulating values, light weight, resiliency, and corrosion resistance. All are retained at 2300° F. In some cases, this fiber can be used successfully up to 3000° F. It is supplied in long and short staple, rope, board, paper, block, blanket, etc.

These products are but two of the many super refractories pioneered by Carborundum. Among them you are almost certain to find answers to your refractory and high-temperature problems. For help, fill in and mail this coupon today.

CARBORUNDUM
Registered Trade Mark

MAIL THIS COUPON TODAY

Refractories Division,
The Carborundum Company, Perth Amboy, N. J., Dept. H47

Please send me:

- ☐ Forthcoming issue of Refractories Magazine
- ☐ Bulletin on Properties of Carborundum's Super Refractories
- ☐ Here is a description of my high temperature problem. Can you help me?

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

These 25 Editors Supplied the Basic Information

Kenneth B. Barnes, Editor.....*Oil and Gas Journal*
Fischer Black, Editor.....*Electrical World*
Roger W. Bolz, Editor.....*Automation*
William Bradbury, Ed. Director.....*Mechanization*
John R. Callaham, Ed.-in-Chief.....*Chemical Engineering*
Harry Chandler, Copy Editor.....*Steel*
H. R. Clauser, Editor.....*Materials and Methods*
J. R. Custer, Editor.....*Automotive Industries*
A. W. J. Dyck, Ed. Director.....*Paper Industry*
John C. W. Evans, Editor.....*Paper Trade Journal*
Ivan A. Given, Editor.....*Coal Age*
David A. Glenn, Editor.....*Industrial Laboratories*
Edward E. Grazda, Editor.....*Electronic Design*
D. L. Hemmenway, Sr. Assoc. Ed.....*Electric Light and Power*
N. H. Jacobson, Editor.....*Electric Light and Power*
W. W. MacDonald, Exec. Editor.....*Electronics*
R. L. Marinello, Managing Editor.....*Plant Engineering*
W. J. Murphy, Ed. Director.....*Applied Journals, ACS*
G. F. Nordenholt, Editor.....*Product Engineering*
L. N. Rowley, Editor.....*Power*
R. L. Stedfield, Assoc. Man. Editor.....*Machine Design*
George F. Sullivan, Editor.....*The Iron Age*
E. J. Tangerman, Exec. Editor.....*Product Engineering*
R. H. Wilcox, Managing Editor.....*Mill and Factory*

completeness, structure, visual aids and readability. Does the manuscript contain all essential information it needs to present the technique or development? Is the manuscript well-organized? Is the information presented in a clear and terse manner? Do illustrations support the central theme of the article? And finally, is your article readable?

The feelings of all editors on these points are strong. They do feel, for example, that the manuscript should be complete. However, many of them admit that if the article is on a subject they want to cover, they will go back to the author for more information.

On structure and organization, this is their reaction: It isn't often that an article will be turned down solely because of faulty organization or style. Editors are far more interested in content than in style, for usually a considerable reorganization and restyling job is done anyway. That's just part of the editor's daily job.

Often, though, the editor insists on changes that will shorten articles, liven them up, make them easier to read and to understand, broaden their appeal and sharpen their approach.

What's in It For You

As an author, you gain more professionally and personally through the technical articles you write than any other person. There is no surer, nor easier way to establish a professional reputation than by publishing useful, well-prepared and authoritative articles that get the serious attention of people in your field.

Your name becomes a part of their vocabularies.

You'll find, too, that the discipline of writing forces you to organize your thoughts and data rigorously. This in turn, can lead to brand new ideas, concepts or explanations. It can lead to new patent applications.

Then there's another benefit: the keen lasting personal satisfaction of knowing that you're passing along information that'll help engineers everywhere do a better job now and for years to come.

Finally, there's the honorarium. Sometimes this is in cash, sometimes in reprints. Generally, but not always, the choice is yours. This honorarium can never come anywhere near compensating you for your specialized knowledge or experience, nor even for your time in preparing the article. But it does represent supplemental income and this may be of some interest to you.

How Editors Help Authors

There are several ways that an editor can help you as an author and a supplier of technical information. However, the vital key to all of them is to get in touch with the editor early—directly or through your public relations department.

From necessity, editors have to be specialists in two things: types of editorial material their readers want; and how to present this material so as to spark and hold interest. Therefore, the sooner you start working with an editor, the easier it will be for him to pass along his tips.

The moment you begin thinking of writing an article, let the editor of the magazine you think will be interested know something about it before you start serious work. If convenient, drop in and see him. If you can't do this, send him a short outline of what you have in mind and how you intend to treat it. Then he can let you know at once whether he's interested.

This might save you a lot of work. Your article idea may be a perfectly good one, yet more suitable for some other publication. Or, it just may be the editor already has on hand a manuscript along the same lines. In either case, it would be to your advantage to know right at the start that the magazine couldn't publish your material.

There's another advantage, too. Once the editor knows exactly the type of article you're preparing he can work out with you a publication date that'll give it a priority on his schedule. Otherwise, you may have to wait around for several months.

Finally, getting in touch with the editor early permits him to come up with a special story tailored exclusively for his audience.

Her nose knows her preference in paints – and she follows her nose to the store that sells paints made with odorless solvents. You can produce superior odorless paints with Sinclair's team of top-quality Odorless Solvents. Light and Heavy Odorless Solvents are available in full and split tank car quantities. For your protection against contamination, Sinclair maintains a fleet of special tank cars, used exclusively in Odorless Solvent service. Prompt shipments to meet your production requirements are assured.

Sinclair Odorless Solvent Light – Distillation Range 345-400°F
Sinclair Odorless Solvent Heavy – Distillation Range 375-465°F

For samples, prices, and complete information on Sinclair Odorless Solvents, write or call . . .

SINCLAIR CHEMICALS, INC.

(Affiliate of Sinclair Refining Company)

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He will dig deeper to make the story hit harder and wear longer than today's news or run-of-the-mill release variety. That will be to your advantage as well as to the magazine's.

There's another way you can profit by getting in touch with the editor early in the planning stage of your article. He can often tip you off to some tricks of the trade that'll get better attention for your story.

One of the things he'll tell you is that the reader wants to know two things immediately. They are:

- What's this about?
- Why should I read it?

This information should be in the first paragraph of the story. If the reader gets past this paragraph, he has only one more question:

- Where is the proof?

Ideally, the technical article does not stray from this pattern. If, as you develop your story, you have doubt about the value of a paragraph or a page for this reason, drop it. Better that you do it than for an editor to have to suggest it. Don't be afraid that a manuscript is too brief. Depend as heavily as you can on graphic illustrations to carry your message; but keep the charts, tables and graphs as simple as possible.

Writing Disciplines Thinking

Most engineers look upon writing as an ordeal because they are not prepared to write. Writing is nothing more than disciplined thinking and until your thoughts are crystallized, you'll have difficulty putting them down on paper.

Here are some things you can do to help you get started:

- Talk over the subject of your article with someone else. In so doing, you'll be forced to organize your thinking to express yourself and to answer his questions.
- Start writing even though you do not feel prepared. By the time you reach the second or third page, you'll hit upon the key to the puzzle. Stop right there. Tear up what you have written. Start where you should have in the first place.
- If you absolutely cannot get started, "sleep" on your story. The pieces often fall into the right places the next day.
- If you are one of those unfortunate persons who has trouble writing because words get in your way, you should acquaint yourself with the writings of Flesch and Gunning. Three points they make are fundamental: Write as you would talk; keep your sentences short; and use simple words.

Then there is the matter of grammar. Many rules—like the split infinitive or preposition at the end of a sentence—have nothing to do with meaning. They are mere matters of form. They often get in the way, make a thought hard to express. Not only that, the product is stilted.

Many editors take this stand on grammar: If the rule of grammar is necessary to understanding, it should be followed. If it is a matter of form, break it if it gets in the way.

Picture a Jigsaw Puzzle

On organization, here is a viewpoint that might help. Picture your article as a jigsaw puzzle. In the lead paragraph you give the reader a fast look at the completed puzzle. He gets an idea of what the whole picture looks like.

Then, in effect you take a duplicate of this puzzle and assemble it piece-by-piece before readers eyes. Because he already has a notion of what the picture looks like, you must not confuse him or throw in pieces that do not fit.

The pieces must go into the right places and in the proper order. This means you must be logical; one thought must flow into the next. Which gets back to what has already been said: Writing is disciplined thinking.

To Adapt a Technical Report

You may decide to adapt a technical report for presentation as a technical article. Just a few words of advice.

You must keep this fact in mind: The reader of a technical magazine is interested in the results and the application of the results. Therefore, your article need not be as exhaustive or detailed as your technical report.

Of all the things we've said about writing technical articles, the most important one is to get in touch with the editor early in your planning. Certainly, you should query the editor about the feasibility of adapting your technical report to a technical article before you begin working on it.

He can save you time and effort for he can guide you every step of the tortuous way in writing a technical article and in getting it published.

JOB APPEALS

. . . *That Get Engineers*

Whether or not there really is an engineer shortage, many companies have embarked on classified advertising campaigns to snare more technical help.

What kind of job appeal can you use to attract technical people?

McGraw-Hill's classified advertising department has just completed a survey of 57 cooperating companies that have added engineers in recent months. New employees were asked to rate the job appeals that swayed them most.

Here's what they said in 2,596 returned questionnaires:

Opportunity within the company is the most attractive job bait. On the query sheet "challenging opportunity" and "potential growth of the company"

Next Month: How Does Your Salary Stack Up, Now?

Are you being paid too much? Of course your answer is a rather emphatic and resounding NO! No one is ever overpaid, but there are people who are underpaid and some who are getting exactly what they're worth. Next month You & Your Job will help you make up your own mind on this very personal and important question. We'll analyze—with you—the special report on professional income of engineers just released by Engineers Joint Council for general distribution and assimilation.

DARCO

CHEMICALS DIVISION, ATLAS POWDER COMPANY, WILMINGTON 99, DELAWARE • Atlas Powder Company, Canada, Ltd., Brantford, Ontario, Canada

WANT TO REMOVE ODORS?

Purify with activated carbon

The sense of smell is one of the most critical tests to which customers put your product. Better be sure that no undesirable odors remain to impair sales appeal.

DARCO activated carbon can often do the odor-removal job for you. Many of the impurities that cause odors are the kind of materials that DARCO readily adsorbs, large, complex molecules . . . such as fatty acids or protein degranulations products. The carbon adsorbs these molecules and removes them physically from your product.

At the same time that you clean out unwanted odors, you purify taste, too . . . because the sense of smell is closely associated with the sensation of taste. And in addition, you remove undesirable colors that may detract from the eye appeal of your product.

People who make edible oils, sugar, food ingredients, pharmaceuticals and many other products that must pass the "nose test" have profited by our experience in applying DARCO to deodorizing. If you have an odor problem, call on us.

– chromatography –

Next time you need to take a chemical mixture apart, it might pay to do a little dreaming about how activated carbon could be applied for this purpose, as a selective adsorptive agent.

Selective adsorption, of course, isn't a new idea. It has been used extensively, for instance, in separating various types of hydrocarbons in the complex mixtures that go through petroleum and petrochemical refineries.

Activated carbon, we suspect, might be a useful medium for industrial chromatography. In a separation column of carbon, the most readily adsorbed materials would come out of solution first, then the others would follow in sequence. Naturally there are a lot of problems to be solved . . . such as finding a suitable elution agent to recover the separated materials.

for high-purity uses... DARCO G-60

Some purification jobs, particularly for foods, fine chemicals and pharmaceuticals, require an activated carbon of especially high purity standards . . . to avoid introduction of new impurities during the decolorizing or deodorizing operation.

We make a grade of DARCO especially for this kind of work. It is DARCO G-60, and it is given special processing to produce extremely low ash and solubles, and the smallest silica and iron content of any grade we make. It has the best filtering properties of any DARCO grade and low product retention . . . which means that it holds back a minimum of valuable product.

Some of the products that we recommend DARCO G-60 for are antibiotics, alkaloids, dye intermediates, nylon salts, lactic and citric acids, and other fine chemicals. Write for technical data and samples.

New **ACE RIVICLOR®**
Corrosion-resistant plastic piping

RIVICLOR, newest of all rigid plastic pipe, heads the list for resistance to chemicals and excellent aging characteristics . . . plus high strength, toughness and easy workability.

Riviclor is unplasticized polyvinyl chloride, specially formulated for process piping. Non-toxic, non-flammable, excellent insulating properties. Only half weight of aluminum. Never needs painting. Smooth inner surfaces give you high flow rates with low loss of head.

Approved For Use With Drinking Water

Use Riviclor for all in-plant piping of mild or strong corrosives at normal temperatures . . . for liquid lines where "sweating" or corrosive vapors are problems . . . for underground piping. Pipe, fittings, diaphragm valves from ½" to 2".

Ask for Technical Bulletin CE-56.

ABBREVIATED TABLE OF CHEMICAL RESISTANCE

ACIDS		BASES		MISCELLANEOUS			
Acetic 50%	S	Ammonium Hydroxide 28%	S	Ethyl Alcohol	S	Carbon Tetrachloride	S
Chromic 25%	S	Sodium Hydroxide 50%	S	Methyl Ethyl Ketone	U	Plating Solutions	S
Hydrochloric 38%	S	**HALOGENS**		Gasoline	S	Photographic Solutions	S
Hydrofluoric 50%	L	Sodium Chloride Sat.	S	Mineral Oil	S	**KEY: S—Satisfactory**	
Nitric 20%	S	Ferric Chloride	S	Animal Oil	S	L—Limited to certain applications	
Sulphuric 50%	S	Sodium Hypochlorite 5%	S	Vegetable Oil	S	U—Unsuitable	
Sulphuric 98%	S			Phenol 10%	S		
				Chlorine 5%	L		
				Alum	S		

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

received the same first-place scores.

Money and security ranked second. Starting salary is the second most important consideration in engineers' job selections, with "regular salary increases" and "permanent position" close behind.

A progressive research and development program is important to the job applicant. He places this factor third.

"Company's prestige and reputation" ranked fourth as an employment factor.

Single and married men rate job appeals in almost the same order. However, the married man is more interested in having the employer finance the cost of relocating his family, while the unmarried engineer is interested in nearness to educational facilities, a job with good contacts and tuition for graduate study.

Since the survey sorts replies into age groups, it's interesting to note that engineers under 25 *do not* consider starting salary or regular salary increases as important as they do other factors. The younger engineer wants a company that has a growth potential and that offers challenging opportunities.

WHAT YOU KNOW

• • • *Who Owns It?*

Does your employer own your knowledge? Well, it depends. And it will depend on what the federal courts decide.

Monsanto Chemical Co. has filed suit in Salt Lake federal district court against Charles M. Miller, to prevent Miller from allegedly using "company secrets" in designing an elemental phosphorus plant for a competitor.

Miller, a former Monsanto engineer, is now general manager for Central Farmer's Fertilizer Co., now engaged in constructing a $10-million plant at Georgetown, Idaho.

The suit is also directed against Central Farmers and F. C. Torkelson Co., an engineering firm.

Salt Lake attorney Albert S. Bowen said the federal court was being asked to enjoin Miller

from divulging "confidential and secret information which he allegedly acquired while working for Monsanto in several engineering capacities."

The suit alleged that Miller was now collaborating with Central Farmers and Torkelson in designing the electric furnace to be built in Georgetown.

This design, according to Monsanto, will incorporate "business secrets and designs pioneered by Monsanto." In addition to the injunction, Monsanto asked for unspecified damages.

CHEMICAL PROGRESS

. . . *And Yours*

In every discussion of chemical engineering as a rewarding profession, the problem of raising the engineer's personal prestige in his own community comes up.

Another chance to satisfy this basic need will be upon us in a few weeks. April 8-12 inclusive has been named Chemical Progress Week by the Manufacturing Chemists' Association. General purpose of CPW is to tell the American people what chemistry and chemical engineering mean to them in terms of their daily lives.

This year CPW will have several subthemes to supplement "A Better America Through Chemical Progress." Speakers will be emphasizing the shortage of science teachers, the importance of research and development in the American economy and the growing needs for scientists and engineers.

In commenting on the program for 1957, General J. E. Hull (USA Ret.), MCA president said:

"Last June we published the results of a study which shows that the United States will be short 457,000 scientists and engineers by 1965. The chemical industry alone will be short 93,000 scientists and engineers. Unless efforts are taken to reduce this shortage, our economic and technological growth will slow down. We are undertaking our new science education program with the fervent hope that it will alleviate the shortage."

STAYS TOUGH
AT SUB-ZERO TEMPERATURES

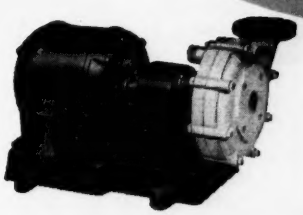
ACE PARIAN . . . odorless, tasteless, rigid polyethylene. Best chemical resistance of any plastic at room temp. except to acetic acid. Excellent impact strength at sub-zero temp. Rigid pipe ½" to 2". *Bul. 351.*

LIFE-TIME
ACID STORAGE TANKS
Rubber-lined by ACE
2-layer system

Economical, universal protection against all alkalis, metallic salts, practically all inorganic acids, hydrochloric acid any strength, sulphuric to 50%, nitric to 20%, phosphoric to 75%. Good to 160 deg. F. . . . sometimes higher. Soft rubber interlayer aids shock resistance.

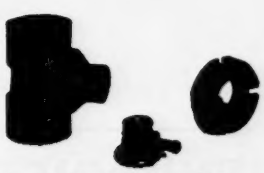
Now eleven ACE Materials to STOP CORROSION

Eleven job-proved rubber and plastic materials now available in ACE piping, valves, pumps and tanks. Tough Ace-lite rubber-plastic blend . . . Saran . . . heat-resistant Tempron . . . Rivicor PVC . . . many others. Write for comparative properties Bulletin CE-50 . . . or call your American Hard Rubber Company distributor.



ACE "WAM" . . . THE FINEST
Non-metallic Acid Pump

On job after job, this 80-gpm. centrifugal pump has earned highest praise. Hard rubber casing and impeller, Hastelloy C shaft. Handles nearly all corrosives. Mechanically simple, trouble-free. *Bulletin CE-55.* Larger ACE pumps available.



NEED SPECIAL FITTINGS,
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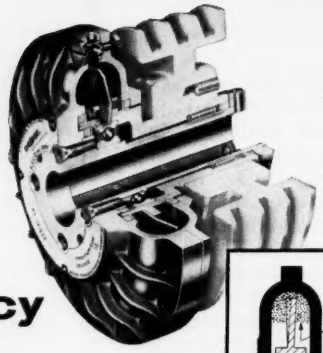
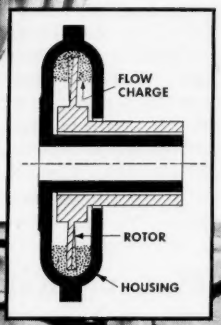
If you want life-time corrosion protection for special parts needed in quantity . . . we may save for you by molding them of ACE hard rubber or plastics to your most exacting requirements. Our facilities among world's largest. Ask for recommendations.

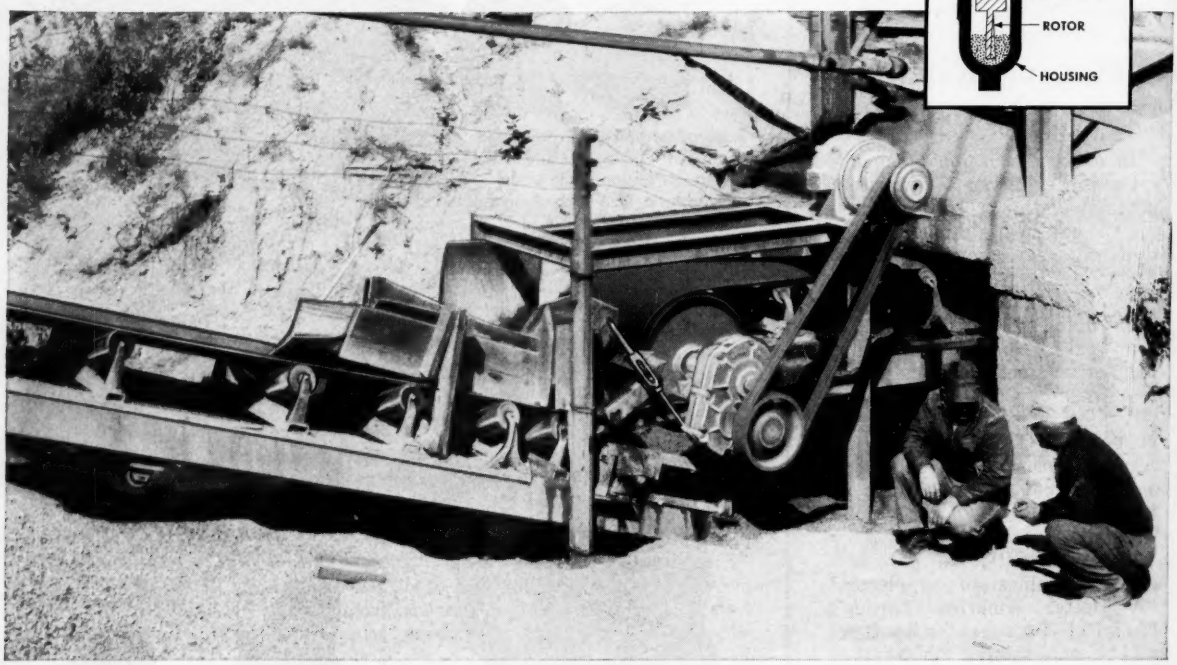
ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

This new drive starts loads smoothly... with smaller motors ...and gives 100% efficiency at full load!







FLEXIDYNE

THE DRY FLUID DRIVE

This tunnel conveyor, 225 feet long, handles 500 tons of sand and gravel per hour—8 to 16 hours a day.

With Flexidyne, the motor picks up the load easily and smoothly. Power investment is reduced, power costs cut, maintenance simplified and conveyor belts are protected against breakage.

Flexidyne, the Dry Fluid Drive, is the *new* development that starts loads smoothly, that protects against shocks and overloads, that saves power and that gives 100% efficiency at full load!

The "dry fluid" in Flexidyne is heat treated steel shot. A measured amount, called the flow charge, is contained in the housing, which is keyed to the motor shaft. When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, wedging it between the housing and the rotor which transmits power to the load.

After a momentary slip between housing and rotor, the two become locked together and achieve full load speed without slip and at 100% efficiency during the running cycle. Changes in weather—hot or cold—inside or out—do not affect operation of Flexidyne.

Flexidyne is now available in 8 sizes—for use with electric motors and internal combustion engines from 1 hp to 300 hp. While each size is power rated, the flow charge can be varied at will to give tailor-made torque for your particular job. Write for Bulletin A-640.

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CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in in your classified phone book, or write us.

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PEOPLE . . .

TECHNICAL BOOKSHELF

J. B. BACON

Monumental

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY. Vol. 15: Waxes to Zymosterol. Edited by Raymond E. Kirk and Donald F. Othmer. Assistant editors: Janet D. Scott and Anthony Standen. Interscience Publishers, New York. 936 pages. Subscription price $25.

For nine years we've been telling you about ECT. Now the encyclopedia is finished.

Complete in 15 volumes, it's ready to serve all who ask for help. The fifteenth volume, with its index, makes that help even easier to get. This index of 620 pages will increase the encyclopedia's usefulness to you. It'll guide you to minor as well as major discussions of whatever you're seeking. For example, paper is covered in Vol. 9. But your Vol. 15 index lists references to some aspect of paper technology in every one of the 15 volumes. Same thing is true of resins and of hydrocarbons. Important materials such as chlorine, glycerine and sulfuric acid show references to 14 different volumes.

To wind up the encyclopedia proper, we find 34 contributors have authored 20 subjects in Vol. 15. These range from waxes through wine, wood, wool, yeasts and zinc to zirconium compounds. And these authoritative articles show the same careful preparation (and editing) we've come to expect in this reflection of American chemical technology.

Accompanying your Vol. 15 will be a few pages of errata for the 14 predecessors. Significance of this extra is twofold. In addition to emphasizing the conscientious attitudes of editors and publishers, its brevity attests the near-perfect job that previous volumes attained.

Elsewhere in this issue of *Chemical Engineering* (p. 353) we record the passing of ECT's senior editor. This loss is a personal one for many of us. But few of us will leave such a monument as did Ray Kirk with his Encyclopedia of Chemical Technology. And even though the ECT is finished, it will continue to grow. Late this year a supplementary volume will start the task of keeping Ray's encyclopedia up-to-date.—LBP

Centripetal Encyclopedia

ENCYCLOPEDIA OF CHEMISTRY. Edited by George L. Clark and Gessner G. Hawley. 545 contributors. Reinhold Publishing Corp., New York. 1,037 pages. $19.50.

This book represents a valuable addition—but not a "must"—for anyone's library.

In 1,006 pages of text, the encyclopedia embraces chemistry and fringes of chemical engineering, physics, metallurgy and biology. To round out the contents, there are such entries as "Automatic Process Control," "Air Pollution," "Chemical Economics" and "Plant Location." Short biographies of outstanding contributors to chemistry—from Democritus to du Nouy—add a welcome flavor to the book.

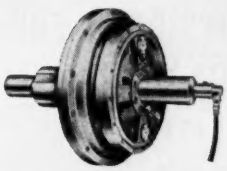
The editors, with contributions from a formidable list of recognized authorities, have come up with a commendable product. The book is well bound; the type, easy to read; the coverage, complete; entries, informative and accurate; style, clear and interesting.

A lunch hour's reading of such diverse entries as "Blood," "Lacquers" and "Semiconductors" will reveal that the volume does a good job of directing these peripheral topics toward a common axis of chemistry, with a high degree of technical competence.

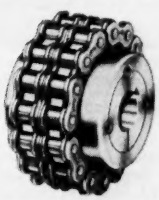
Random examples of excellent condensation are the entries on "Adsorption" (3½ pages), "Nondestructive Testing" (1 page) and "Oxidation" (3 pages).

According to the preface, this encyclopedia is intended to serve

DODGE PRODUCTS you should know



AIR-GRIP CLUTCHES



CHAIN COUPLINGS

SEALED-LIFE V-BELTS

DODGE BULLETINS YOU SHOULD HAVE

- ☑ Air-Grip Clutches. Technical data, sizes and selection tables. Bulletin A634
- ☑ Chain Couplings, Taper-Lock Sprockets and Dodge Roller Chains. Technical data and selection methods. Bulletin A644
- ☑ Sealed-Life V-Belts. Construction details and complete data on sizes, pitch lengths and outside lengths. Bulletin A606

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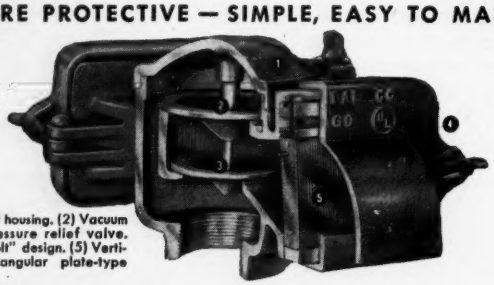

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"chemists, physicists, engineers, biologists, research workers, teachers and students who comprise the scientific population of the world." However, it will not serve the individual in his specialized field of work. The physicist will find the "Raman Effect" entry disappointing; the chemist will search in vain for analytical applications of nuclear magnetic resonance; the research worker will go to some other source for his answers.

Practicing chemical engineers will not get much help with their design problems. There's little emphasis on recent process developments. This has been sacrificed for brevity.

Yet the book has accomplished its purpose of presenting a lot of diverse chemistry and technology as a unified, living subject.—JBB

New Gmelin Volumes

GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY. Issued by the Gmelin Institute. Verlag Chemie, Publishers, Weinheim, Germany. Available from Walter J. Johnson, Inc., 125 E. 23rd St. and Stechert-Hafner, Inc., 31 E. 10th St., New York 3, N. Y.

Reviewed by M. Wulfinghoff

Copper. (System No. 60, Part A. Issue 1, xvi and 710 pages. $92.13. Issue 2, xxxii and 753 pages. $101.98.) In accordance with the great importance of copper in our civilization, this metal has been treated at considerable length. Included in the text are 425 figures, mostly graphs.

Metallurgical details, both as to recovery and to refining, are presented in abundance, and there is also a section on powder metallurgy. Technological factors such as hardness and the influence of deformation, welding and various methods of working are carefully evaluated. Effects of alloying and of impurities on technologically significant properties, such as resistance to chemical attack and electrical conductivity, are given.

Finally, analytical methods

have been compiled and grouped. Literature references are complete up to 1950, and essentially made available up to 1954.

Thorium and Isotopes. (System No. 44, xv and 406 pages. $55.22.) Treatment of thorium follows the typical arrangement: History, occurrence (extraterrestrial and terrestrial). Geophysical and economic data are presented and both laboratory and industrial recovery methods are described.

The volume outlines applications of the metal, its oxides and other compounds in metallurgical, electronic, chemical and other industries, as well as in medicine. The element and its general physical and nuclear, crystallographic, mechanical, thermal, optical, magnetic, electrochemical and general chemical properties are discussed in 100 pages of text. Alloys and compounds follow, and the last 50 pages are devoted to a review of the radioactive isotopes.

Literature references are complete to 1950, and the more important references up to 1954 have been included.

Calcium. (System No. 28, Part B. Issue 1, viii and 264 pages. $34.99.) The volume on calcium technology deals with the various existing methods for treating calcium-bearing raw materials (fluorides, sulfates, carbonates, phosphates) with metallic calcium or its compounds as the end product. Procedures, testing methods and applications are outlined.

Literature references are complete up to the end of 1949.

Up-To-Date Technology

HIGH PRESSURE TECHNOLOGY. By Edward W. Comings. McGraw-Hill Book Co., New York. 572 pages. $11.50.

Reviewed by Paul A. Lobo

Until recently, there has been a noticeable absence of books covering the latest developments in high-pressure technology. Professor Comings' new book fills this void particularly well, since it adequately covers both laboratory and plant applications of high-pressure work.

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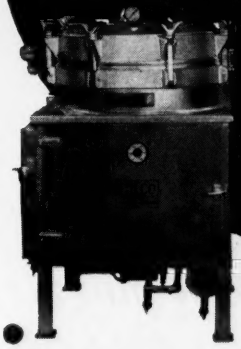

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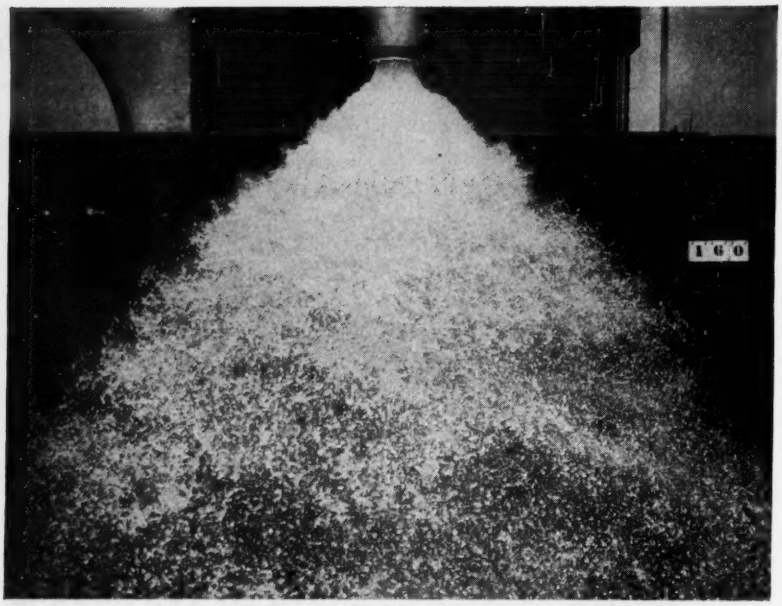

Spraco full-cone, free-flow nozzle discharging 860 gpm at 5 psi. This photo was taken at 1/5000 sec. shutter speed . . . at this speed the pulsations of the pump are apparent in the spray pattern.

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SPRAY ENGINEERING COMPANY

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the volume a helpful reference book of high-pressure experimental techniques. A number of methods for the determination of viscosity, thermal conductivity, heat capacity and PVT data are reviewed. One section describes small-scale pilot plants which have been used successfully for procuring chemical reaction-rate data.

Equations of state useful for predicting or cataloging the behavior of gases under high pressure are presented, and the range of applicability and range of each equation is given.

Included in the extensive appendixes are constants for the Beattie-Bridgman, Van der Waals' and Benedict-Webb-Rubin equations for the most commonly encountered gases. Also, the appendix includes an extensive bibliography of PVT data available in the literature for pure gases and gas mixtures above 5 atm., which will be welcomed by the process design engineer.

A detailed review of ammonia synthesis illustrates the application of thermodynamics, kinetics and reactor design techniques to a commercial process. Synthesis gas purification, catalyst types and economics are covered, as well as a description of several types of commercial-scale reactors now in operation.

Plant and laboratory high-pressure equipment are reviewed from the aspect of the size and pressure range over which each type is applicable. Examples are given of essentially all the various types of reactors and reactor closures appearing in the literature over the past decade.

Many readers possibly would desire to see more emphasis placed on large-scale plant equipment and plant processing problems; however, very little information of this type has knowingly been made available.

Safety aspects of high-pressure work are covered in one chapter, and this section is recommended as required reading for those just entering this field.

A generous amount of space has been given to a discussion of thick-walled vessel design.

This book will be a useful library addition for those concerned with designing high-

pressure vessels and processes as well as for those involved in pilot-plant and laboratory operation.

BRIEFLY NOTED

A NEW LOOK AT THE NATURF OF THE OPEN HEARTH PROCESS. *By B. M. Larsen.* 47 *pp.* $3. *American Institute of Mining, Metallurgical and Petroleum Engineers,* 29 *W.* 39*th St., New York* 18, *N. Y.* Presents a unified analysis of the open-hearth process in relation to factors which control speed and fuel efficiency.

FRICTION AND LUBRICATION. *F. P. Bowden and D. Tabor.* 150 *pp.* $2.25. *John Wiley & Sons, Inc., New York.* Gives a brief account of modern work on the mechanism of friction and lubrication. Includes chapter on friction of non-metallic solids.

HIGH TEMPERATURE—A TOOL FOR THE FUTURE. *Proceedings of a symposium at the Stanford Research Institute, University of California. Published by the Stanford Research Institute.* 218 *pp.* $5. Discusses methods of reaching high temperatures, materials for containing high temperatures and processes occurring at high temperatures.

NUCLEAR REACTOR DATA 2. 21 *pp.* $1 *up to* 10 *copies. Raytheon Mfg. Co., Waltham* 54, *Mass.* Gives important charactertistics of 142 reactors throughout the world.

OILY SUBSTANCES AND THEIR EFFECTS ON THE BENEFICIAL USES OF WATER. *By Jack E. McKee.* 71 *pp.* $1.25. *California State Printing Div., Documents Section, Sacramento* 14, *Calif. A* comprehensive survey and evaluation of the printed literature.

MORE NEW BOOKS

ARCS IN INERT ATMOSPHERES AND VACUUM. Edited by W. E. Kuhn. Wiley. $7.50.

ELEMENTS OF GASDYNAMICS. By H. W. Liepmann and A. Roshko. Wiley. $11.

QUALITY CONTROL FOR PLASTICS ENGINEERS. Edited by L. M. Debing. Reinhold. $4.95.

TEXTBOOK OF POLYMER CHEMISTRY. By F. W. Billmeyer, Jr. Interscience. $10.50.

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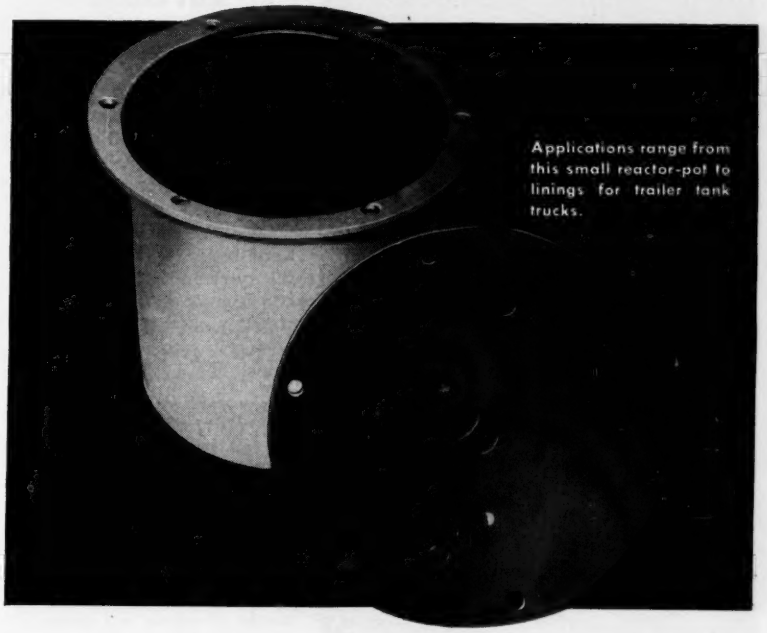

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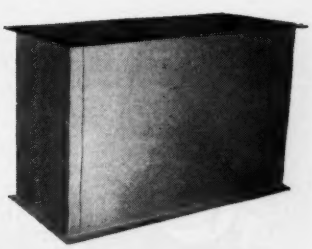

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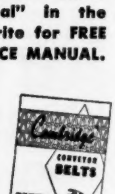

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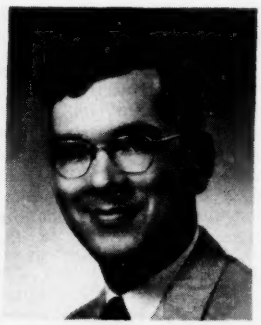

James O. Osburn

CE REFRESHER PAGE 284

It's a man-size job to write even one installment of our CE Refresher Series. So now that Jim Osburn has dealt out six doses in a row, we feel he deserves to appear in these columns again. (See our previous writeup in November 1956, p. 415.)

As you read over Osburn's work you're probably impressed by its quality. But we here on *Chemical Engineering* are doubly impressed: In addition to the high caliber of his work, Osburn is extremely efficient in turning it out. We've never yet had "deadline" trouble with him. If we tell him to send in his material by a certain date, he'll get it here with time to spare. Considering the difficulties involved in organizing such difficult material, this is not only unusual, it's hard to believe.

Though we've never really doubted Osburn personally, we did have quite a scare during the Christmas holidays. Osburn lives out in Iowa where he's associate professor of chemical engineering at the State University in Iowa City. Just before the turn of the year, most of the state was in a wild frenzy as the Iowa Hawkeyes (university football team) succeeded in swamping Notre Dame and Michigan. The way lay clear for a triumphal appearance in California's Rose Bowl. And our author's material was due on the momentous New Year's day.

Here in New York, we hadn't heard from Jim in a week or so.

AUTHORS

M. A. GIBBONS

Granted the Christmas mails were slowing things up. But for all we knew, our author had probably been swept up by the peculiar "feverus Bowlus Rosus" which claimed so many. We were beginning to wonder if he wasn't already on a train heading west.

But our fears were unfounded. The manuscript arrived on New Year's eve, in typical Osburn style. And, in answer to our frantic questions, his letter explained that his family wasn't particularly interested in football.

On top of that, Osburn claims he does his best these days not to let too many things distract him from his tall commitment to the CE Refresher. He says he now has a good idea of what former author Tom Corrigan must have gone through when he did 38 issues in a row.

P.S. Iowa won.

F. Duncan Berkeley

EJECTORS GIVE ANY SUCTION PRESSURE PAGE 255

It's always good to welcome back old friends. And when the old friends are former authors it's twice as good.

Readers will recall F. Duncan Berkeley as author of the very successful and popular article, "Air Ejectors Cheaper Than Steam," which appeared in our Nov. 1954 issue, p. 164.

Currently, Berkeley is an application and design engineer, for the Graham Manufacturing Co., Batavia, N. Y. He started out with the firm in 1946 during

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AUTHORS . . .

a summer vacation from school. Soon after, he took on his first full-time assignment as an engineer in the heat transfer division. For a time, he worked for the firm's vacuum division as a design and development engineer and he also spent some time in the Chicago office as a sales engineer.

Berkeley has already achieved some recognition for his grasp of ejector technology. One of his papers on the subject placed first in an ASME local section contest, in Chicago, last Spring.

His educational background includes attendance at Williston Academy in Easthampton, Mass. When he graduated from the Academy in 1946, Berkeley headed for Troy, N. Y., where he earned a B. S. in mechanical engineering four years later.

He is a member of the AIChE, the ASME.

H. C. McDaniel

HOW TO GET YOUR NEXT ARTICLE PUBLISHED.
PAGE 311

H. C. McDaniel is director of Westinghouse's technical information section, information services department, Pittsburgh, Pa. It's his job to supervise technical publicity operations and *The Westinghouse Engineer* magazine.

In letting you in on his technical writing "know-how," McDaniel draws on fourteen years experience in the field. McDaniel was already with Westinghouse when he joined techcnical publicity in September 1943. He started out as writer-editor but before five years had passed he had become manager of technical publicity.

And, in September 1954, he was appointed manager of technical information.

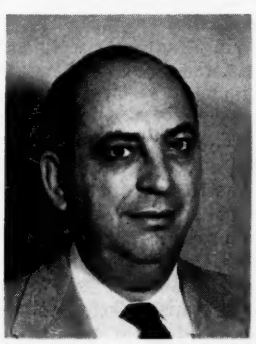
Before getting into publicity, McDaniel had been a district engineer for the firm's lamp division in Pittsburgh, Pa. He originally joined the firm in July 1939, as a commercial engineer.

McDaniel's first post-college position was with Pacific Power and Light Co., Portland, Ore. Following a two-year training period, he became company lighting sales engineer. He left the firm in July 1934 to join Central Illinois Public Service Co. as manager of lighting sales. Three years later, he became manager of merchandise sales.

A varied assortment of interests keeps McDaniel busy outside the office. He's an amateur photographer and identifies himself as "a golfer of sorts." Memberships include the Foreign Policy Assn., a country club board of directors and the greens committee (of which he's also chairman).

Professional associations have included the AIEE, the Illuminating Engineering Society, the Assn. of Technical Writers and Editors, and the Nuclear Energy Writers' Assn.

McDaniel acquired all of his formal education in the Northwest. He graduated from Oregon State College in Corvallis, Ore., in June 1926, with a B. S. in electrical engineering.



Charles J. Veith

HOW TO CHECK EQUIPMENT QUALITY PAGE 261

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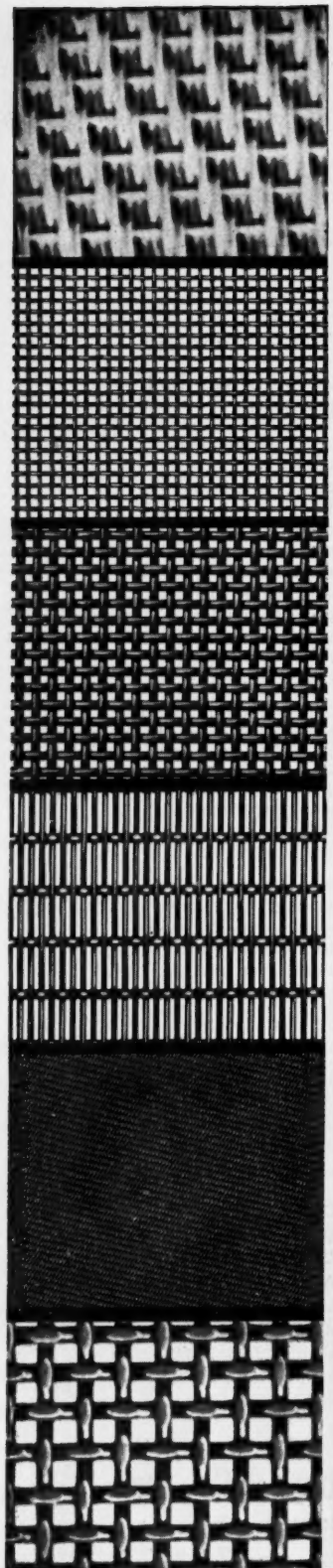
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AUTHORS . . .

ess is up to par. In writing this article, it was Charles Veith's idea to give you a hand in choosing the right method for each specific situation.

And Veith is well qualified to do just that. For the past 12 years, he has been superintendent of the material and equipment section in the construction division of Du Pont's engineering department. It's his responsibility to look to the control of quality and delivery of purchased material and equipment for the construction of new plants (those built by Du Pont both for its own use and for the government).

During a peak period in 1953, when the firm was building the Savannah River AEC plant, the material and equipment section expanded to include a staff of over 500 employees. It was at this time that Veith gained much of the experience directly responsible for this article. For, equipment at the Savannah River operation, required the use of numerous new nondestructive testing techniques—a first-time use for many.

Going back a bit, Veith's career had its beginnings at Syracuse University. While still an undergraduate, he got his first testing experience as a student engineer with General Electric Co.

After earning his degree in mechanical engineering, Veith joined du Pont's engineering department in Wilmington. That was in 1936. By 1944, he had become chief engineer.

During the war years, du Pont constructed many smokeless powder and TNT plants, as well as the Hanford, Wash., (Manhattan Project) plant for the manufacture of plutonium. Veith's job was to look to the construction of special equipment for these projects and to supervise the force of field inspectors.

Early in 1945, he was appointed to his present position as superintendent of the materials and equipment section.

On the homefront, Veith's son is currently in his second year at Tufts University, School of Dental Medicine, in Boston.

He admits to golfing as his main hobby, which he plays "anytime there is no snow on the course."

H. E. Tracy

SELECT BEST PUMP SEAL
PAGE 300

When Harold Tracy first contacted us, we knew we had a short but darn good article on pumps for atomic reactors on hand.

A few days later, a period of careful preparation and negotiation was underway. There was a flood of phone calls, teletypes, outline revisions and conferences involving editorial people in New York, McGraw-Hill's San Francisco staff and Tracy in Los Angeles. The result was a sizeable expansion in the scope of the article.

By the time our author was ready to write, he had a full-scale report on his schedule. And the final goal was to evaluate the latest methods of sealing centrifugal pumps—a subject of interest to all chemical engineers.

Tracy has worked in the pump field for more than 30 years. He joined Byron Jackson Pumps Inc. in April 1926 and he's been with the firm ever since.

His work with the Los Angeles firm has included assignments in both sales and mechanical design. Until 1940, he worked in pump sales in California and in Texas. Then, for the next 15 years, he served as director of mechanical design in the pump division engineering department.

During this period, he visited the field on a number of occasions each year to assist in solving various pump problems. And, he also carried out the design and development of the Byron Jackson mechanical seal.

Just two years ago, Tracy was appointed product sales manager for mechanical seals. At present, he devotes all his time to their development and sale.

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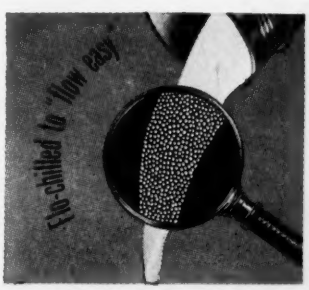

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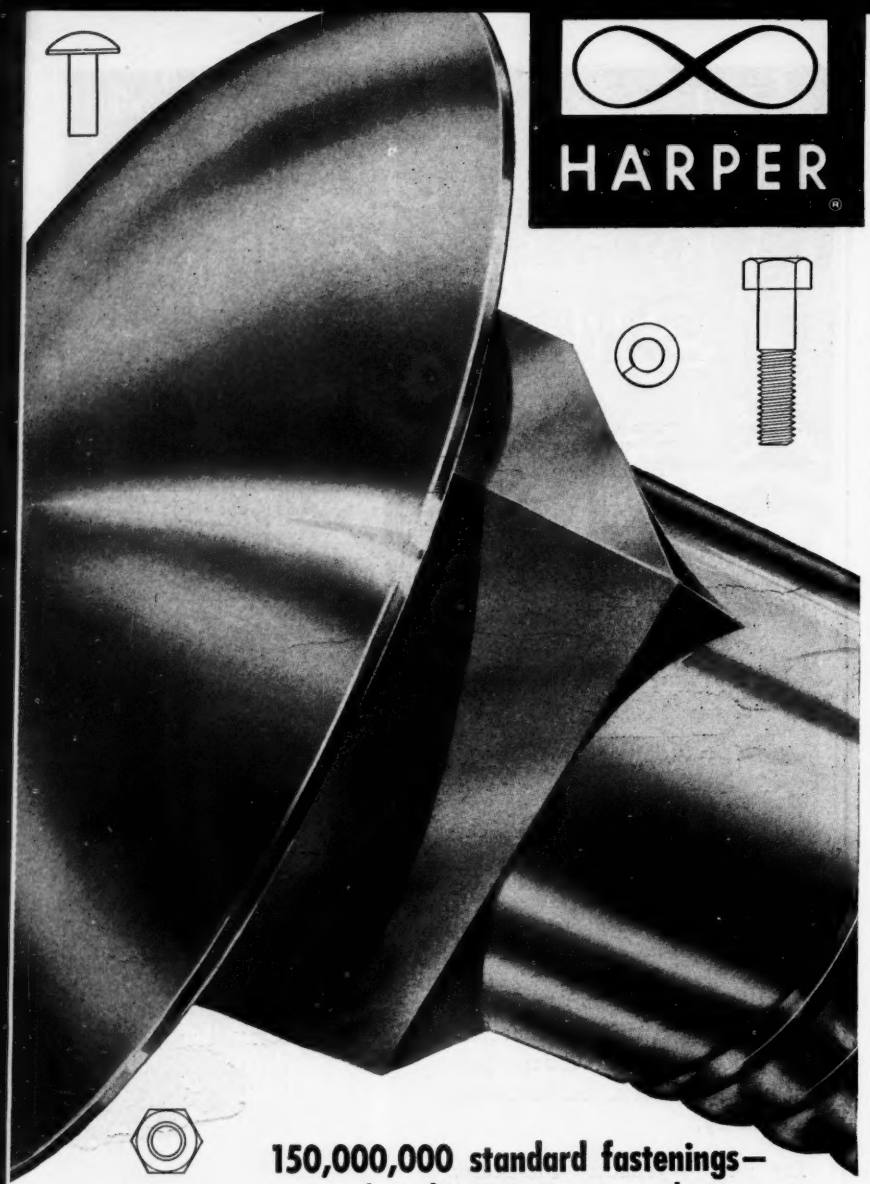

150,000,000 standard fastenings—
...on hand BEFORE you order!

NUTS, for instance—hex, square, cap, castellated, heavy, finished, regular, wing, and knurled, in brass, bronze, stainless, aluminum, copper, nickel, monel. The exact fastening you need, on hand BEFORE you order. Your nearby Harper Distributor is a fastening specialist. He knows your problems. He'll give you quick service. Why shop? Why wait? Make just one telephone call to your Harper Distributor, and get immediate delivery.

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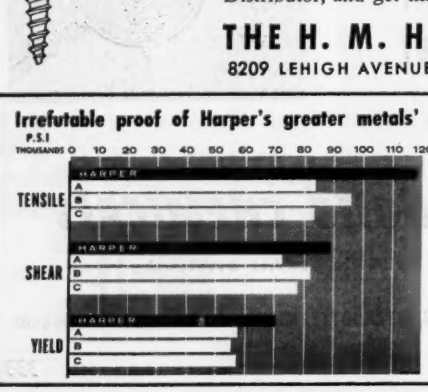
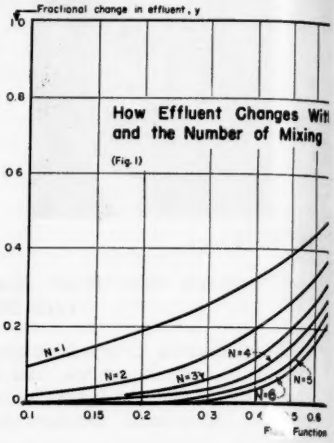


An important point in buying fastenings is strength. Independent laboratory tests*, utilizing Stainless Steel Machine Bolts by Harper and three other leading producers, prove Harper superiority in Tensile, Shear, and Yield Strength. The chart at left shows the actual results of these tests. For complete information on these important tests, request Form No. 126.

*By R. W. Hunt Laboratories

PEOPLE . . .

LETTERS:



Analysis of Mixing Stages

Sir:

First, a compliment on undertaking a series of articles on the estimation of physical properties. This is something that is much needed and will be a valued addition to my files.

I would also like to question a small part of the article, "New Tool Analyzes Mixing Stages" (Feb. 1957, pp. 241-242).

In Fig. 1 there is a curve which supposedly represents an infinite number of mixing stages. The text refers to it as that for "a perfect longitudinal reactor in which no backmixing takes place."

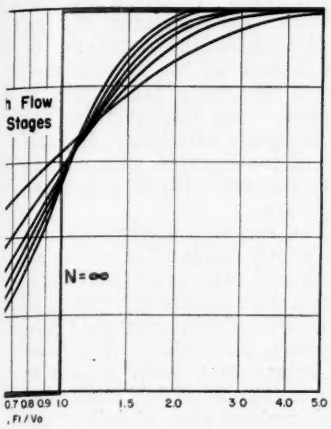
While my mathematical level does not permit my solving the equation for an infinite number of stages, I am almost certain that such a curve would have the form shown in the corrected graph (*see above*).

Other than this the article does a good job of drawing attention to the fact that actual mixing stages can be expressed in terms of ideal stages. However, experimental data are

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. They'll be welcomed.

PRO & CON

EDITED BY C. H. CHILTON



needed to show the degree of correlation which can be obtained.

EDWARD D. HENZE
E. I. du Pont de Nemours & Co.
Wilmington, Del.

▶*Mr. Henze is right. The curve labeled infinity in the article should be identified as* $N = 6$.—ED.

Vessel Design Problems

Sir:

I have several comments on Mr. Schneider's article, "How to Buy Pressure Vessels" (Dec. 1956, pp. 179-182).

The initial part of the article emphasizes the necessity for advising the fabricator fully as to service requirements, citing cyclic operation and attendant fatigue as one example and subzero service as the other example.

The second example is not appropriate, since service temperature represents a minimum essential for design and must be specified for compliance with the Code.

Nor is the first example appropriate, for the Code provides no guidance as to design for cyclic service (fatigue), leaving the purchaser to his own discretion.

In its present content the ASME Pressure Vessel Code (Section VIII) is a new construction Code, leaving to the

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Harper FLO-FORM Process
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Mr. Montgomery, who works with the highly specialized industrial plants in the Cincinnati area, is typical of the Harper Application Engineering Service. Monty's broad knowledge and vast experience in fastenings problems enables him to work closely with design engineers to solve their problems.

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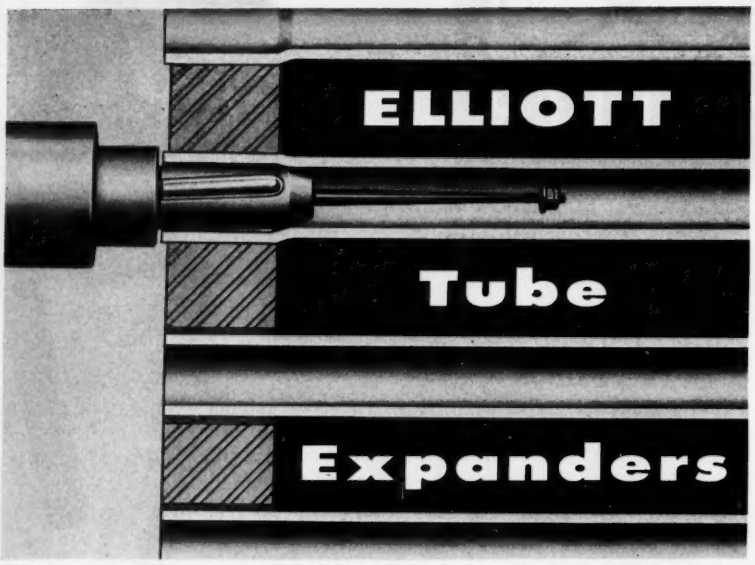

with ELECTRICAL CONTROLS for tight, uniform tube joints

Assures air- or water-tight joint between tube and tube sheet by use of rotating, parallel self-feeding rolls. Elliott expanders have adjustable ball-bearing thrust collars, and rolls having a radius on front and back ends. Available in 4 types, for tubes ¼" through 3", 14 gage.

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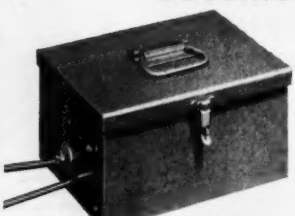
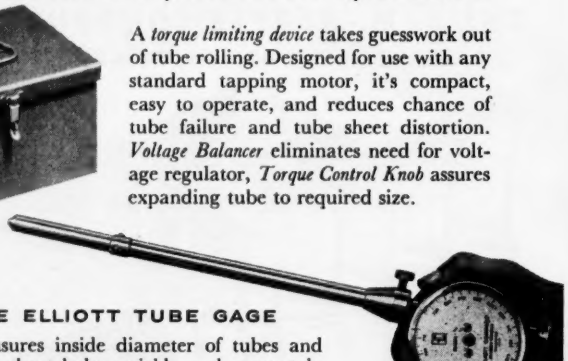


A *torque limiting device* takes guesswork out of tube rolling. Designed for use with any standard tapping motor, it's compact, easy to operate, and reduces chance of tube failure and tube sheet distortion. *Voltage Balancer* eliminates need for voltage regulator, *Torque Control Knob* assures expanding tube to required size.



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purchaser and enforcement authorities the responsibility for selection of design, materials, fabrication and inspection requirements suitable for the service involved (including deterioration). The fabricator will no doubt advise the purchaser to the extent of his knowledge—which for many fabricators is limited—but responsibility for an adequate association of quality of construction with service severity rests with the purchaser and user.

The second paragraph under "Support, Ladders" is not at all clear and may cause confusion. The author apparently wishes to emphasize that partial field fabrication, particularly if limited in extent, may prove expensive due to the cost of field inspection and, perhaps also, of field stress relief and radiographic examination where involved.

Finally, the author has left a gap between the purchaser's requirements—and assurance as to their fulfillment within the limitations of his article—and the engineering contribution to be expected from an average pressure vessel fabricator working to the Code. A "well-engineered" vessel cannot be expected to result from the usual competition between fabricators, which normally results in furnishing the absolute minimum the Code permits without particular consideration for the expected service conditions of the individual vessel.

D. B. ROSSHEIM
M. W. Kellogg Co.
New York, N. Y.

Sir:

I can easily clarify the point of possible confusion cited by Mr. Rossheim. The appurtenance referred to may be a ladder welded to the vessel. The ladder is not a part of the Code vessel, but the weld joining the ladder to the shell is. Accordingly, the welding proceduce and the welder must be qualified in accordance with Section IX of the Code, and the other appropriate sections of the Code must be applied.

Basically, I agree with Mr. Rossheim that the Code places the responsibility for selection

of design, materials, etc., on the shoulders of the purchaser and enforcement authorities. Furthermore, the Code represents minimum requirements, all of which may not be suitable for a particular vessel operating under certain conditions.

On the other hand, many purchasers charge the fabricator with design responsibility as well as actual fabrication. Admittedly, the purchaser still has certain responsibilities; however, when the fabricator also does the designing for Code construction, he must accept the design criteria and other conditions specified by the purchaser, provided they do not violate minimum Code requirements.

I wholeheartedly agree with Mr. Rossheim's last statement concerning the usual competition between fabricators. If a purchaser shops for price alone, the possible attendant complications must be recognized.

Incidentally, since publication of this article, three similar errors in purchasing pressure vessels have come to my attention from industry.

In each case the purchaser specified the vessel to be "in accordance with" the ASME Unfired Pressure Vessel Code, and the supplier quoted accordingly. The vessels were completed but could not be ASME-Code stamped because each fabricator was not in possession of the necessary ASME authorization and Code symbol stamp. Why did the problem arise?

The answer is probably the misuse of the English language. The purchaser wanted a Code vessel, so stamped, while the fabricator interpreted "in accordance with" as meaning only the design and workmanship provisions of the Code.

R. W. SCHNEIDER
Travelers Indemnity Co.
Hartford, Conn.

Pro: Good Grasp

Sir:

Melvin Goldberg's article, "'56 Pesticides: Ups and Downs" (Dec. 1956, pp. 276-280), is a very fine review of the agricultural chemicals picture for last year.

It is obvious that Mr. Gold-

DIAPHRAGM VALVES

Positive control for all corrosive services, slurries, liquids, gases, air and water

The exclusive sealing bead diaphragm assures leak-tight closure in all Hills-McCanna Diaphragm Valves. This packless valve with only three components provides simple in-line maintenance.

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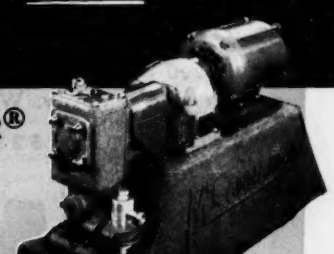
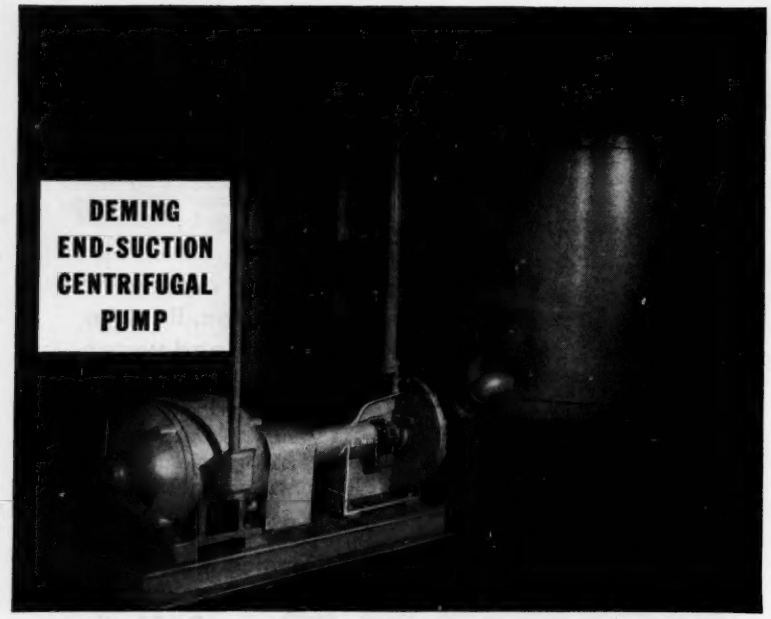


Pat. appl. for

Hills-McCanna Company, 2341 W. Nelson Ave., Chicago 18, Illinois



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The Problem: To obtain an adequate supply of water to meet the increased demand of expanded production involving continuous cooling to constant temperature.

The Obstacle: An overtaxed well that supplied water at close to capacity with no reserve.

The Solution: A revised cooling system which included a Deming End Suction Centrifugal Pump and a fresh water supply tank. Water is pumped rapidly through cooling lines and returned to the tank. A self-acting temperature flow valve opens a tap to permit fresh, cool water to supply the system as needed.

The Savings: The Deming Pump and the revised recirculating system reduced the amount of water required by 115,000 gallons per day. So successful is this system that three similar systems are now in operation by the same company.

What's YOUR pumping problem? The diversified line of *standardized* DEMING PUMPS gives you a wide selection for type, size and capacity. Write for details.

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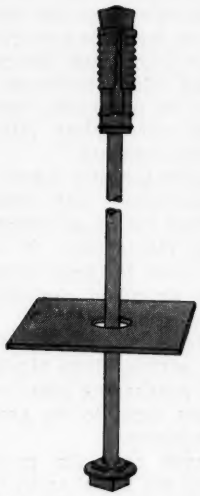
DEMING

"the Line that has Everything"
IN
PUMPS AND WATER SYSTEMS

berg has a good grasp of industry situations and problems. The article is accurate and should be especially helpful to many who have a substantial interest in agricultural chemicals but are not directly connected with the industry.

C. D. FISCHER
Carbide & Carbon Chemicals Co.
New York, N. Y.



Cf. Coal-Mine Roof Bolt

Sir:

Because of rather widespread interest in my series of articles on storage hoppers, and in light of certain fairly recent developments, it seems worthwhile to emphasize one point which has been shown more by implication.

When the discharge gate of a hopper is opened and some material drops out, pressure under remaining material becomes zero, and a vertical pressure gradient develops. The magnitude of such a pressure gradient is limited by the tensile strength of the material in its compacted state. (Another name for tensile strength, in this case, is cohesion.)

Some materials develop tensile strength to such a degree that mechanical aid is required for discharge. With other materials it suffices to design for maximum discharge pressure in order that the pressure gradient may exceed the tensile strength of the compacted material. Then material will actually be pushed and the arch will destroy itself.

An analogy may be drawn from a coal mine, where roof bolts are used to supply the tensile strength required to support the overhead material.

CHESMAN A. LEE
Evanston, Ill.

▶*Mr. Lee's articles on hopper design appeared in April 1952, May 1953 and Dec. 1954.*—ED.

Liquid CO_2 vs. Dry Ice

Sir:

I am sorry to see that someone has made a mistake in your article about Calder Hall entitled "Large-Scale Atomic Energy Makes Its Debut" (Dec. 1956, pp. 114-116).

You state that "carbon dioxide, generated from dry ice, sweeps into the bottom of the pressure vessel."

This statement seems to have been based on outdated information on the early experimental stages of this project. In the full-scale operation, liquid carbon dioxide is stored in bulk and gasified as needed. Dry ice was abandoned for several reasons, among them the fact that recharging of the dry ice converters could not be carried out without introducing air into the coolant circuit.

A. F. B. NEAL
Distillers Co. Ltd.
London, England

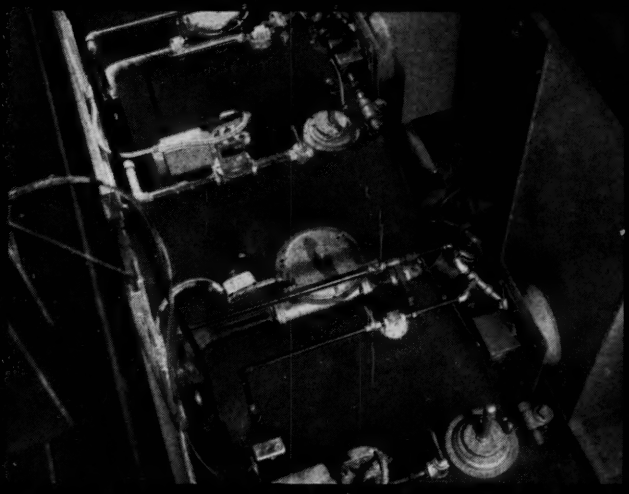
Pro: Getting Ahead

Sir:

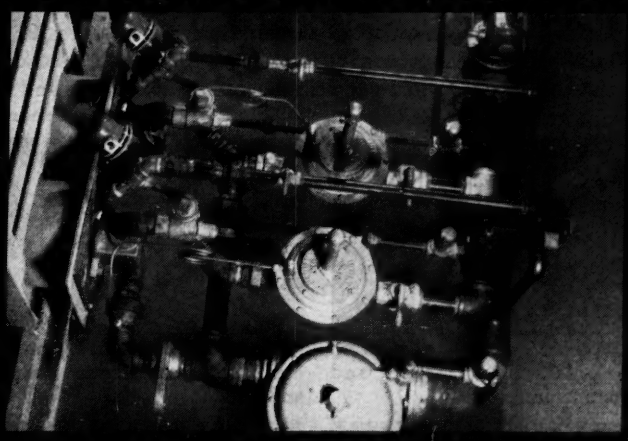
Congratulations on a job well done! Your article, "These New Books Can Help You Get Ahead" (Dec. 1956, pp. 228-234), was a valuable Christmas present.

You might want to pass the word around that chemical engineers can get another present and save themselves some money. The first two books on your list can be obtained at a 15% discount by joining the McGraw-Hill Business Book Club, and another valuable book, "Developing Your Executive Skills," by Auren Uris, can be obtained free. Many of us have shelled out $4.50 for the latter and have never regretted it.

SAM FEDERMAN
General Aniline & Film Corp.
Linden, N. J.



-fires immersion heating tanks



for finishing aluminum!

Here are two of six Eclipse Combustion Assemblies designed for heating tanks used for putting a hard oxide finish on aluminum by Cupples Products Company, St. Louis, Missouri—leading manufacturer of aluminum windows and curtain wall. The assemblies include Eclipse nozzle mixing gas burners, combustion safeguards, zero gas governors, gas cocks, safety shut-off valves, blast gates, and automatic temperature control valves. Tanks are pit-mounted and burners are fired into large, 30 ft tubes for immersion heating of solutions for cleaning, etching, and sealing. If you have process heating problems, Eclipse will design combustion assemblies to meet your special requirements. Write for catalog describing Eclipse Burners, Blowers, Mixers, and Valves—the most complete line of combustion components available from any *one source!*

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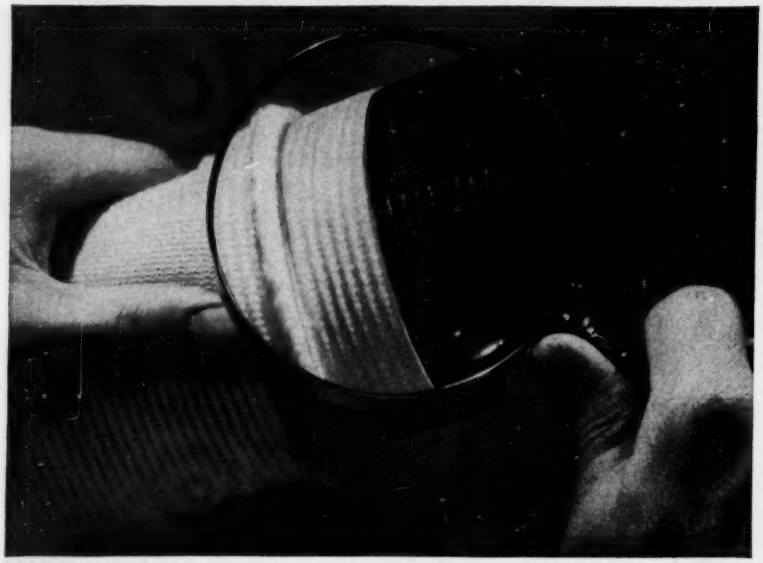
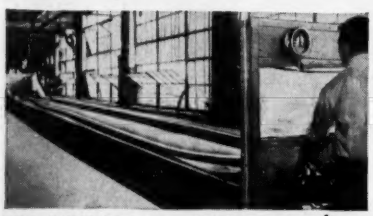
Pictures tell why **PETROCHEM** does **MORE** than fight fire

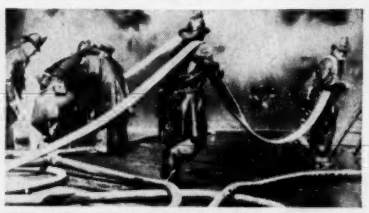


IT'S RUGGED . . . stands up to abrasion, resists weather. PETROCHEM'S oil-resistant Neoprene tube is enclosed in a tough, wear-defying Dacron* jacket. It's a rugged, light, flexible fire hose that wears and wears.

*Reg. T.M. E.I. Dupont de Nemours & Co.



IT'S STRONG . . . strong enough to withstand 500 lbs. pressure and 300°F. temperature.



IT'S OIL AND CHEMICAL RESISTANT . . . fights off deterioration both inside and out.

IT'S FLEXIBLE . . . so flexible it takes tight twists without injury.

IT'S EASILY COILED . . . requires a minimum of storage space.

These are the reasons why it will pay you to consider PETROCHEM fire hose in your safety planning. Your Quaker-Quaker Pioneer distributor provides extra-fast service. See him today. For more information, please write to: *H. K. Porter Company, Inc., Quaker Rubber Division, Philadelphia 24, Pa., or Quaker Pioneer Rubber Division, Pittsburg, Calif.*

HKP QUAKER RUBBER DIVISION
QUAKER PIONEER RUBBER DIVISION
H. K. PORTER COMPANY, INC.

PEOPLE . . . NAMES IN

T. J. Gillick, Jr.

New manager of American Felt Co.'s engineering and research activities is Thomas J. Gillick, Jr.

From 1949—when Gillick joined American Felt—until 1954, he was chief chemist and director of quality control at the firm's Glenville, Conn., plant. Then, late in 1954, he was appointed director of engineering.

Earlier in his career, Gillick had been a research chemist and colorist with the Hat Corp. of America and a dyer with Geo. A. McLachlan & Sons, hat manufacturers.

Gillick, his wife, and two sons make their home in Norwalk, Conn.

Thomas H. Vaughn has been named executive vice president in charge of corporate development of Pabst Brewing Co. As a former vice president of the Colgate-Palmolive Co., Vaughn directed a world-wide research and development program.

Clem O. Miller has been appointed executive secretary of the division of chemistry and chemical technology of the Nat'l Academy of Sciences, Nat'l Research Council. Miller is a well-known figure in the pharmaceutical field.

Raymond A. Erickson, Robert A. Moody and **William M. Swanson** are newly appointed members of the petrochemical process sales de-

THE NEWS

M. A. GIBBONS

partment of Universal Oil Products Co., Des Plaines, Ill.

Ralph W. Kienker has been promoted from engineering supervisor to manager in the engineering department at Monsanto Chemical's Texas City, Tex., plastics division operation.

Edward A. O'Neal, Jr., president of Chemstrand Corp., has been named chairman of the board of Chemstrand Ltd., London. Also named to the board was **Sir Miles Thomas**—chairman of the board of Monsanto Chemicals, Ltd.

James A. Merrill

The manager of the technical division of Goodyear Atomic Corp., Portsmouth, Ohio, has returned to the parent Goodyear Tire & Rubber Co., in Akron, as associate director of research and development.

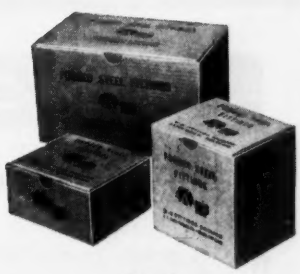
James Merrill, the man in question, has been with the firm for the past 27 years. In fact, he took his first job with Goodyear immediately following graduation from Massachusetts Institute of Technology.

One of Chemical Engineer Merrill's most important assignments with Goodyear was his work in self-sealing gas tank research. He developed fuel tank design and construction to such an advanced state that he earned a presidential citation at the suggestion of the Air Force.

A few years back, Merrill was

NOW *a Modern Fittings Package*

one more reason for specifying
W-S FORGED STEEL FITTINGS



W-S Forged Steel Fittings are now being shipped in strong, lightweight fiberboard cartons designed to make purchasing a pleasure. Shipments are made up of unit cartons packaged inside a larger reinforced carton. It's easy... and advantageous to order your fittings in packaged quantities.

Here are additional advantages of the new W-S package:

1. Compact and easy to handle.
2. Ideal for neat, efficient stacking on warehouse and stockroom shelves.
3. Sealed against dust and moisture.
4. Contents clearly marked on outside face of each carton, readily visible for prompt identification.

The new W-S package is only one of many reasons why W-S Forged Steel Fittings are the most widely accepted by industry.

Don't forget, too, W-S carbon steel fittings have the additional protection of their new blue synthetic coating. For detailed information on packaged lots ... and for a copy of our new fittings catalog, write today to W-S Fittings Division, H. K. Porter Company, Inc., Roselle, N.J.

Sold Through Leading Distributors

HKP W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.

Add flexibility to your machines with low-cost speed control

Choose from 8 sizes . . . ¼ to 15 hp . . . 1.75:1 to 4:1 speed ratio. Converts any standard constant-speed motor into variable speed drive.
MAXIMUM TO MINIMUM OUTPUT SPEED POSITIONS

REEVES®

Vari-Speed Motor Pulley

Get greater productivity . . . run at the most economical production speed . . . handle production or process variables with the same machine—install low-cost REEVES Vari-Speed Motor Pulleys!

Change machine output speeds . . . instantly and accurately . . . without interrupting production. Positive "close-grooving" lubrication assures free sliding discs for *easy, sure* speed adjustment. Minimum parts mean long, trouble-free service.

Write today—CE29a-V545; we'll send your copy of the Motor Pulley bulletin complete with rating data and dimensions.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

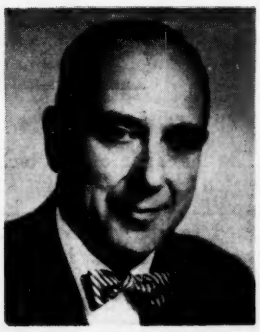
one of 27 key men who helped organize Goodyear Atomic Corp. —set up to operate the AEC's huge Southern Ohio gaseous diffusion plant. He first became GAT's manager of the Laboratory division and, later, head of the technical division.

The Merrills live in Chillicothe, Ohio.

E. Van Dornick has been appointed vice president and corporation director in charge of the refinery and chemical division of Macco Corp., Paramount, Calif. He is former director of engineering of the oil and gas facilities division of Arabian American Oil Co.

Troy B. Hunt has been named plant manager of Olin Revere Metals Corp.'s reduction plant at Amal, Ohio. Till now, Hunt had been with Olin Mathieson Chemical Corp.

Frank Eichelberger, Jr., has been named general manager of Northwest Refining & Chemical's new refining plant in Spokane, Wash.



C. F. Rassweiler

Vice chairman of the board and vice president for research and development at Johns-Manville Corp., N. Y.—Clifford Rassweiler—has been chosen to receive the Chemical Industry Medal for 1957 for "conspicuous services to applied chemistry."

Formal presentation of the award will be made at a meeting of the Society of Chemical Industry's American Section, at New York's Waldorf-Astoria Hotel, on October 18, 1957.

Rassweiler first came to Johns-Manville as director of research and development, in 1951, after 17 years with Du Pont's research outfit. Six years ago, he was elected vice chairman of the board of Johns-Manville. This was in addition to his responsibilities as vice president for research and development—a post he'd taken on in 1942.

Herbert J. Dutton

A $1,000 1956 Glycerine Research Award, given by the Glycerine Producers' Assn., has been won by Herbert J. Dutton—U. S. Department of Agriculture research chemist.

Dutton received the award for his work on the application of a recently developed extraction technique to investigate complex natural glycerides such as linseed oil.

The award was presented at a luncheon on January 24 during a meeting of the Glycerine Producers' Assn. at the Waldorf-Astoria, in New York.

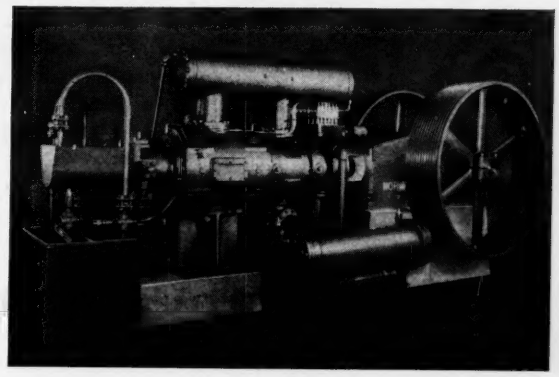
Roy D. Wiggins has been appointed to the research and development section, textile division, The Hilton-Davis Chemical Co., Cincinnati.

Richard N. Hill, of International Minerals & Chemicals' research division, in Lakeland, Fla., has been promoted to development manager in the Perlite department of the firm's industrial minerals division in Los Angeles.

A. V. Quine has been appointed general manager of Lucky Mc Uranium Corp., Riverton, Wyo. He had been general superintendent of the Col-

NORWALK

HIGH PRESSURE COMPRESSOR



The five stages on this heavy-duty tandem compressor require less horsepower and develop less heat than in four stages in producing 3000 lb. per square inch pressure in capacities up to 31,000 cfh.

Frames with double row roller bearings, reversible ring plate valves, force feed lubrication, generous intercooler coils are some of the features that make this horizontal compressor compact, sturdy and efficient to operate and maintain.

Every Norwalk compressor is test-run for eight hours at the factory, then taken down for complete inspection before re-assembly and shipment.

Norwalk makes compressors from single stage to six stages, from 125 to 25,000 lb. psi. Catalog on request.

NORWALK COMPANY, INC.

SOUTH NORWALK, CONNECTICUT

Established 1864

This aluminum casting is part of a missile fuel pump. Its $\frac{5}{16}$" walls must pass a 1500 psi pressure test with no impregnation permitted. Interior walls are smooth and true as cast.

If your processing equipment requires parts with demanding metallurgical properties, close tolerances and intricacy, our unique foundry techniques may provide a solution. A number of demanding parts for nuclear and chemical applications have already been cast. Send for our illustrated technical booklet.

Morris Bean & Company
Yellow Springs 12, Ohio

porosity free castings!

BEAN

NAMES . . .

ville, Wash. lead-zinc operation of Goldfield Consolidated Mines Co.

Solomon Caplan is now technical director of Irvington Chemical division of Minnesota Mining & Mfg. Co., Newark, N. J.

Harold Gartner

Former superintendent for American Latex Products' Hawthorne, Calif., plant is now vice president in charge of the firm's production operations.

In his new position, Harold B. Gartner will be in charge of the manufacture of ALPCO's foam rubber, plastics, and adhesives divisions as well as of the maintenance and engineering departments.

Gartner was one of the plant's original employees. His first assignment, in 1939, was that of rubber fabricator.

Thirty-six year old Gartner lives in Gardena, Calif.

Charles F. McMacklin has been appointed superintendent of the Portland, Ore., plant of Stauffer Chemical Co. He succeeds **John B. Gay,** who is now plant manager at Vernon, Calif.

Edmund Field has been appointed senior research associate and Herbert Friedlander is now group leader at the Whiting, Ind., laboratories of Standard Oil Co. (Ind.).

Emil F. Werly has joined the staff of Midwest Research Institute's chemical engineering division, Kansas City, Mo.

For the past year he has been associated with Dawes Laboratories, Chicago.

James W. Dunham, a National Cylinder Gas Co. vice president, has been named president of the Compressed Gas Assn.

Malcolm T. McCants has opened new consulting engineering offices in the Texas Nat'l Bank Building, Houston, Tex., to serve the petroleum and petrochemical industries.

Robert W. Harrell has joined Ethyl Corp.'s research and development department in Baton Rouge, La., as operations supervisor in manufacturing. Other new members are: **James J. Mullen, Doyal Wright,** and **Edwin D. Hornbaker.**

Harry F. Vickers, president and director of the Sperry Rand Corp. has been elected a director of The Flintkote Co., paper board manufacturer.

W. J. Shelton, resident manager of the new kraft pulp and paper mill under construction by Georgia-Pacific Paper Co., Toledo, Ore., is now a vice president of the firm.

John W. Weisel has joined B. F. Goodrich Chemical Co. as a junior technical man at the firm's plant No. 3 in Akron, Ohio.

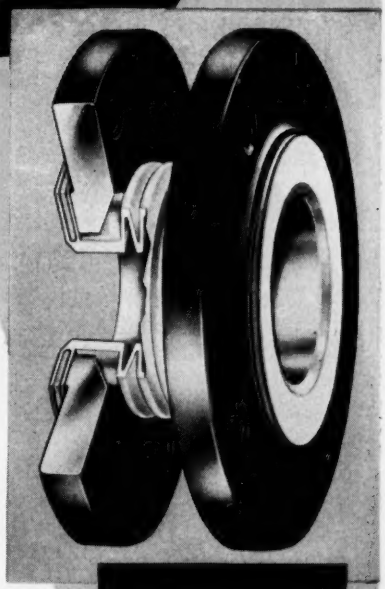
Orlo Myers has joined the department of scientific research at the Convair division of General Dynamics Corp., San Diego, Calif., as senior staff scientist in chemistry.

Edwin Schlesinger has been appointed manager of the engineering department of the dyestuff and chemical division plant of General Aniline & Film Corp., in Linden, N. J.

Walter F. Rogers, chief chemist at Gulf Oil's Houston, Tex., production division chemical laboratory, has won the 1957 Frank Newman Speller award

Here's The Plain Truth About
CHEMLON®
Flexible Pipe Connectors

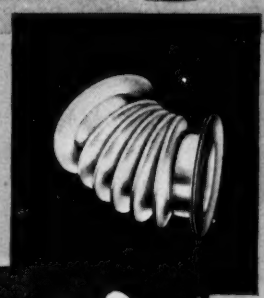
*"John Crane" fabricated from DuPont Teflon



When it is a question of chemical piping—where you need anti-corrosive protection, plus long life—Chemlon Connectors best meet the need. They are fabricated from the most chemically resistant material available, DuPont Teflon. The most destructive acids, corrosives and solvents have no deteriorating affect*

Other important advantages are their long service-life, extreme flexing ability and wide temperature range from −65°F. to +350°F.

Chemlon flexible pipe connectors offer a definite plus value construction-wise. 1) They are made from Teflon specially fabricated for high and uniform density. 2) An exclusive manufacturing method assures uniform wall thickness throughout the convoluted area. 3) They are formed at full free length to reduce residual and working strain to an absolute minimum.

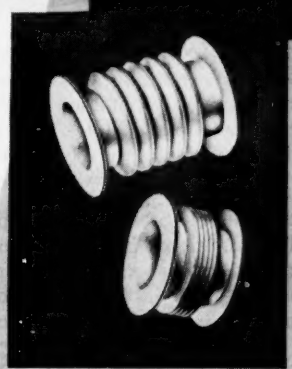


Vibration and Misalignment

—severest vibration and misalignment conditions, such as pump to agitator or mixer to tank, will cause little deterioration or fatigue. Also, the Chemlon Flexible Pipe Connector serves as an acoustical as well as a mechanical dampener.

Expansion and Contraction

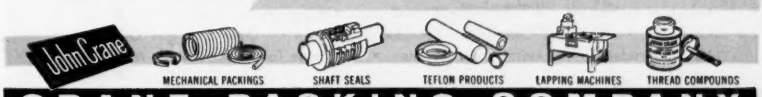
—continuous flexing over a wide range of temperature conditions has little affect on Chemlon Flexible Pipe Connectors.



Chemlon Flexible Pipe Connectors handle pressures to 75 psi., dependent on size. They can be supplied to fit any pipe size from ½" to 12" and are available with companion flanges conforming to American Standard Class 125 Cast-Iron Pipe Flange specifications.

Request full information. Crane Packing Co., 6451 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

**Except fluorine and molten alkali metals.*



CRANE PACKING COMPANY

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

New Series 8000 Multi-point Recorders Feature Easy Reading, Operation, and Service

Swing-out design making all components readily accessible in Series 8000 multi-point recorder is demonstrated below. Cover of recorder mechanism removed to show construction.

Permanent recording of as many as 16 points on one chart — at standard recording speeds ranging from 3 to 24 inches per hour — is readily obtained on Wheelco Series 8000 multi-point recorders. Thermocouples, radiation detectors, and other sensing devices that resolve the measured variable into an electrical signal all work equally well with the new recorders.

Additional features include: up to six limit switches for high and/or low signal indication, single or multi-color printing, and fast cross-chart speed. Call your nearby Wheelco field engineer today for Bulletin F-7955, or to discuss how these multi-point recorders can improve your processing.

BARBER-COLMAN COMPANY

Dept. P, 1585 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. O, Toronto and Montreal, Canada

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Electrical Components • Small Motors • Overdoors and Operators Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

NAMES . . .

for achievements in corrosion engineering.

K. M. Bartlett has been elected president of Horizons, Inc., materials and process research organization of Cleveland.

Clayton K. Cole has been named assistant chief engineer in charge of material handling products manufactured by Borg-Warner Corp.'s Ingersoll Kalamazoo division, Kalamazoo, Mich.

Maynard M. Baldwin

New technical director at Battelle Institute, Columbus, Ohio, is Maynard M. Baldwin. In his new post, Baldwin will guide technical aspects of the Institute's extensive chemical research.

An authority on derivatives of coal tar, lignite, and mineral oil, Baldwin's varied research interests have included wood products preservation, agricultural and pharmaceutical chemicals, coke oven by-products, and organic synthesis.

Baldwin graduated from Whitman College with a B.S. in chemistry and earned a Ph. D. at the University of Washington. He joined Battelle in 1938 after some years with the School of Mineral Industries, Pennsylvania State College.

Alan G. Richards has been appointed director of applications for Bjorksten Research Laboratories for Industry, Inc., Madison, Wis.

Edward S. Roberts, former vice-president and chief engineer

of Chemical Construction Corp., has become a member of Barsky & Strauss, Inc., consulting firm, New York.

John P. Holmes, vice president of Celanese Corp. of America, has been assigned to direct the company's foreign operations.

K. R. Gerhart has been promoted to superintendent of plant operations for Continental Oil's Sherwood refining division. He'll make his headquarters in Gretna, La. **Thomas Karolenko** will now supervise the firm's Chicago plant, succeeding Gerhart.

Alvin D. Hues, former chief chemist at the Oregon Steel Mills, Inc., Portland, Ore., has joined the staff of the Los Alamos laboratory of the University of California.

Walter H. Salzenberg, assistant general manager of Du Pont's Grasselli Chemicals department, will succeed **J. A. Almquist** as assistant general manager of the firm's polychemicals department.

Stephen F. Malaker, general manager of Daystrom Nuclear, will direct operations at a new reactor center in West Caldwell, N. J. Purpose is to manufacture research reactors and train personnel for the campus and for industry.

A. Y. Bethune has been named manager of metallurgy for the Bunker Hill Co., San Francisco. He'll succeed **Harold Lee**, who is now VP in charge of research and development. Bethune will be headquartered at the firm's Kellogg, Ida., reduction plant.

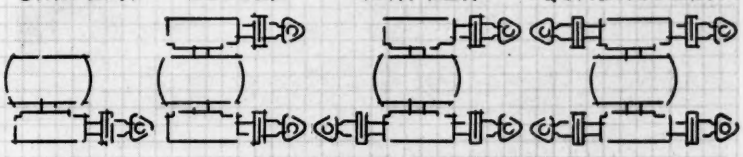
C. M. Vanderwaart and **Leon Lazare** have been appointed managers of process design sections in American Cyanamid Co.'s process engineering department.

Walter G. Andrews, manager of Archer-Daniels-Midland resin and plastics division; and **Ralph Bruce**, manager of the

advanced design in high pressure pumps

4 different pump arrangements —all on the same baseplate

SIMPLEX DUPLEX TRIPLEX QUADRUPLEX



Versatile—to suit any requirement now or later (frames are designed for ease in compounding any simplex or duplex pump). Multiple units avoid large piston areas vs. high pressures. Obtain high capacities and close proportioning with reduced horsepower requirement.

3 basic pump-frame sizes

for 2-in., 3-in., and 4-in. strokes, and 16 piston sizes from .250 in. to 2.750 in. Offering a pump capacity range from 30 cc per hr. (smallest simplex) to 2000 gph (largest quadruplex).

2 basic types of drive

CRANK ARM

Used where a sine curve output is required, and on compounded pumps. Provides suction and discharge strokes on equal 180° arcs of the eccentric.

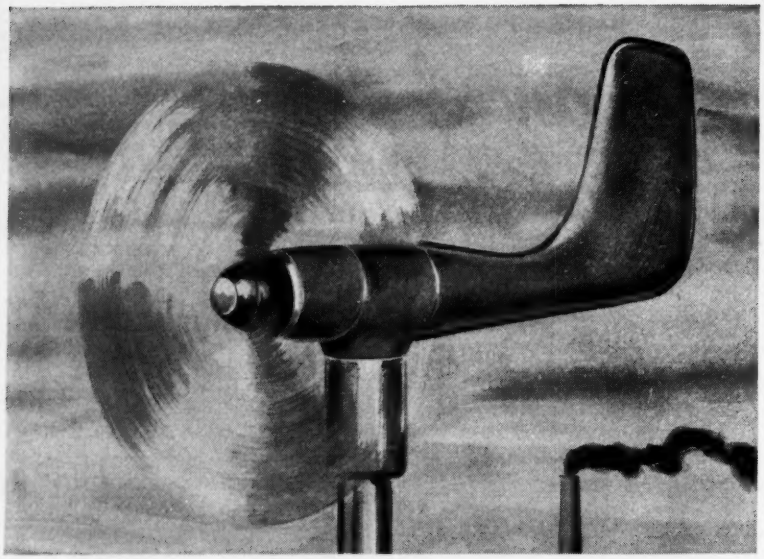
YOKE DRIVE

The answer to the high power requirements of high pressure pumping. Employs 240° of the eccentric's arc for discharge, 120° for suction. Spreading work load over greater distance reduces power requirements up to 25%.

Write for Bulletin HP-1254

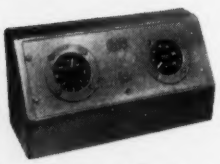
PHILADELPHIA SERIES HP HIGH PRESSURE PUMPS

PHILADELPHIA PUMP & MACHINERY COMPANY
13500 Philmont Avenue, Philadelphia 16, Pa.
SUBSIDIARY, AMERICAN METER COMPANY



The Aerovane Transmitter detects wind speed and direction, electrically transmits data to indicator and recorder, and actuates control mechanism.

BENDIX AEROVANE* SYSTEM HELPS SOLVE AIR POLLUTION PROBLEMS



Indicator shows wind speed and direction. Calibrated in compass degrees and miles per hour.

Recorder inks wind speed and direction on time-calibrated chart. At normal setting, operates continuously for two-week period.

Optional indicator-controller reduces operating cost of blowers, deodorizers and scrubbers by providing automatic on-off control.

Here's how you can relieve air pollution problems in connection with your plant—and, incidentally, save your company endless headaches. The Bendix-Friez Aerovane System can be of tremendous value to you in eliminating costly and bothersome litigation, saving you money and building good public relations in the community where your plant is located.

If your stacks emit an odorous or possibly dangerous effluent, you must take steps to prevent it from harming personal health, crops or residences in the surrounding area. Bendix-Friez Aerovane System can help do the job as economically as possible.

Here's how it works. When winds are from an unfavorable quadrant, and blowing at velocities which indicate the likelihood of injurious fall-out, your Aerovane System goes to work. It actuates your blowers, deodorizers and scrubbers *only* when conditions require their use. At the same time, the Aerovane Recorder keeps a continuous and accurate, permanent record of *both* wind direction and speed. If litigation does develop, you'll have unquestionable evidence of wind conditions at any given hour.

In addition, the recorder provides an opportunity for the study of wind gustiness, an important factor in predicting the behavior of an effluent from a stack.

These are just a few of the reasons why you ought to investigate the Bendix-Friez Aerovane System if you have a factory-based pollution problem. Write today for full details. Bendix-Friez, 1418 Taylor Avenue, Baltimore 4, Maryland.

*REG. U.S. PAT. OFF.

Friez Instrument Division

Bendix AVIATION CORPORATION

NAMES . . .

firm's linseed division, have been named vice presidents of the firm.

A new industrial consulting firm—Calkin & Bayley, Inc.—has been set up with **John B. Calkin** as president; **George T. Bayley,** executive vice president; **Robert Frank,** VP in charge of marketing and economic research; and **John L. Parsons,** VP in charge of pulp and paper.

William B. Hall, general manager of Vitro Uranium Co., Salt Lake City, Utah, is now president and general manager of the firm. **Richard C. Cole** has been elected VP of the uranium division.

Leon M. Atlas has been promoted to senior scientist at Armour Research Foundation of Illinois Institute of Technology, Chicago.

Frank McGrane, former head of western potash sales for American Potash & Chemical Corp., Los Angeles, has been named to head a new consolidated sales section which will handle all agricultural chemical products from the Los Angeles and Trona, Calif., plants.

J. L. Tathwell, former chief project engineer; and **F. G. Crawford,** former manager of project coordination, have been promoted to newly created positions as managers of projects at The Flour Corp., Ltd., Los Angles.

Arnold Hanchett has been appointed assistant director of development for Solvay Process division, Allied Chemical & Dye Corp. Hanchett was named to his former position of technical manager of Solvay's development department.

John L. Rendall has been appointed associate director of Minnesota Mining & Mfg.'s central research department in St. Paul, Minn.

Charles F. McMacklin, formerly with Stauffer Chemical's

Richmond, Calif., plant, is now superintendent of the No. Portland, Ore., unit. He succeeds **John B. Gay,** who has been transferred to Richmond as plant manager.

E. G. Partridge has been appointed director, Rubber Technology Foundation, University of California's school of engineering. Formerly, he had been senior development engineer for B. F. Goodrich's adhesives division.

J. F. Roorda, operating department manager at the Norco, La., plant of Shell Chemical Co., has been transferred to the Houston plant as operating department manager.

Edward Oliphant, Jr., has been promoted to the position of group leader at Standard Oil Co.'s Sugar Creek, Mo., research department laboratory.

Robert M. Woolfolk, Jr., has joined Texas Gas Corp. as chief engineer, in Houston, Texas. Formerly, he held a similar position with The California Co.

William D. Millar, Jr., division superintendent, blast furnaces at U.S. Steel Corp.'s So. Chicago plant, has been transferred to the firm's Fairless Works at Morrisville, Pa., as division superintendent.

Lawrence C. Byck, Jr., has been named manager of heavy chemical sales for U. S. Industrial Chemicals Co., division of Nat'l Distillers Products Corp.

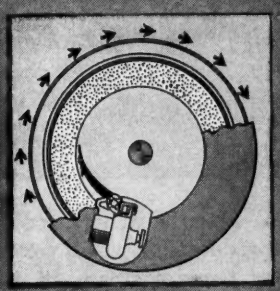
J. J. Porterfield is now general superintendent of refining operations for American Crystal Sugar Co., Denver. He succeeds **Frank M. Sabine,** who resigned recently.

W. Albert Noyes Jr., dean of the University of Rochester's graduate school, has won the 1957 Willard Gibbs Medal in chemistry for his "contributions to science . . . as a researcher, teacher, govern-

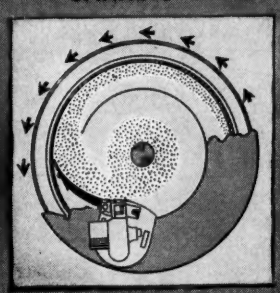
safe

CENTRIFUGALS

Keep plant accidents at a minimum and maintain constant production with the safest centrifugal in the chemical industry today.
The Roberts G-8 Automatic Electric Drive Centrifugal features many unique developements which until now have been wanted, but not achieved.



SPINNING



PLOWING

REVERSE PLOWING—Completely eliminates the hazard of accidental plowing during the spinning operation. (See illustration.)

OVERLOAD PROTECTION—Loading gate closes automatically when basket has received predetermined charge.

TEMPERATURE—High speed connections are further protected by thermal overload device built into the motor.

CURBING—Completely enclosed.

UNBALANCED LOAD PROTECTION—Gyration Switch protects machine against possible damage caused by unbalanced load.

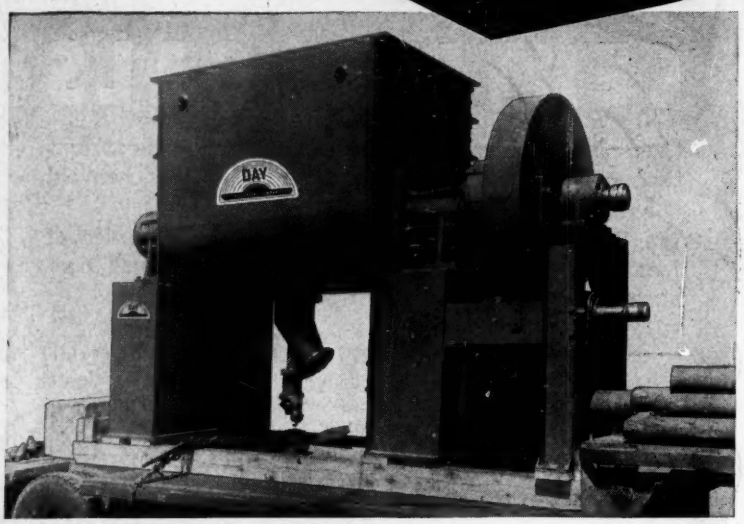
REGENERATIVE & MECHANICAL BRAKING—Quick, safe stops are achieved with the G-8 braking system.

These are just a few of the many new features which THE WESTERN STATES MACHINE COMPANY has developed and incorporated into its machines. For additional FREE information on Roberts Centrifugals write The Western States Machine Company, 1700 Fairgrove Avenue, Hamilton, Ohio.

ROBERTS STEVENS

The WESTERN STATES MACHINE COMPANY
HAMILTON, OHIO, U.S.A.

NOW!



DAY CLAY MIXER . . . . the most advanced design available anywhere, has a record of productivity that is virtually unequalled. A service story from a large paper company, testified that a Day Cincinnatus Clay Mixer dispersed within 60 minutes a 75% solids, clay mix, into a homogenized product, with binder savings averaging 10 to 20%.

The tremendous, power-packed mixing action of heavy steel, dispersion contoured agitators, working the batch against itself as well as against tank bottom, sides, and ends, rapidly pressures the binders and wetting agents into the pigments. The result is a smooth gritless coating that will meet both you and your customers highest standards.

Unretouched photo of 75% solid clay mix used in test.

Ruggedly built, precisely engineered, for 24 hour operation the Day mixer is available in 5, 200, 350, 550, 660, 1000 gal. pasting capacities. Get full details in Data Sheet No. I-300 CM, then let a Day field engineer tell you about higher production, dollar savings with a Day Cincinnatus Mixer.

FOUNDED 1887

in mixing equipment **DAY** *means longer life span*

THE J. H. DAY COMPANY

4926 BEECH STREET, CINCINNATI 12, OHIO

Division of Cleveland Automatic Machine Company

Quality equipment for baking, paint and varnish, printing ink, chemical, rubber, pharmaceutical, cosmetics, paper and pulp, explosives, food, ceramics, candy, soap, sugar and milk products.

Mexico: T. de la Pena e Hijos, S. A., Nazas 45-A, Mexico 5—D. F.

NAMES . . .

ment adviser and editor." The award was given at a meeting of the ACS' Chicago section.

Ramon I. Lindberg has been appointed director of corrosion research for A. M. Byers Co., Pittsburgh, Pa. Lindberg has been associated with Sinclair Research Laboratories, Inc., for the past ten years.

Shao E. Tung, Ponca City, Okla., senior chemical engineer in the central research division of Continental Oil Co.'s development and research department, will head a group to do research in the field of catalysis.

Hugh Miller, former president of Corpus Christi Refining Co., has joined Kerr-McGee Oil Industries, Inc., as manager of the firm's Wynnewood, Okla., refinery.

Carl F. Graham is now director of research and development for Turco Products, Inc., Los Angeles, Calif. Formerly, Graham had been associated with Wyandotte Chemical Co.

W. A. Taebel has been appointed engineering manager of the lamp parts department of the Westinghouse Lamp Division, in Bloomfield, N. J.

Geoffrey R. Ward and **Bruce L. Garner** have been named to to the research staff of the Los Angeles Soap Co. as director of research and chemist, respectively.

A. C. Wicker has joined the staff of the sales development department of Tube Turns, Louisville, Ky., division of Nat'l Cylinder Gas Co., Chicago.

Jerald D. Reed has been promoted to the position of plant manager of the Texas City, Tex., plant of Amoco Chemicals Corp.

Lawrence Flett, consultant for Allied Chemical & Dye's Nat'l Aniline division, received honorary membership in the American Institute of Chem-

ists, at a New York dinner meeting, on March 11.

Ralph J. Addesso was recently appointed a senior chemist in U. S. Testing Co.'s chemistry department, at the main laboratories in Hoboken, N. J.

Joseph M. Culotta has been named chief project engineer for the Pfaudler Co., Rochester, N. Y. Culotta had been with National Aniline.

Raymond J. Lodge and **Charles W. Smith** have been appointed departmental general managers for Borden's chemical division.

R. W. Ward, formerly Nopco Chemical plant engineer, will be in charge of all engineering and production for the firm.

L. H. Johnstone was promoted to plant manager at Phillips Chemical's Adams Terminal manufacturing facilities on the Houston Ship Channel. He replaces **R. G. Rhodes** who has been transferred to Bartlesville, Okla., as director of plant operations.

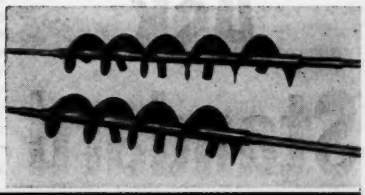
Ben Hagen has been promoted to manager of production planning at San Leandro, Calif., headquarters of Western-Waxide Specialty Packaging Div., Crown Zellerbach Corp.

Anthony Mastrovich is now general manager of operations for Climax Uranium Co., with headquarters at Grand Junction, Colo.

Dwight Dougherty has been appointed general manager of SD Plants, Inc., construction subsidiary of Scientific Design Co., New York.

OBITUARIES

Charles W. Stewart, 69, of Saratoga, Calif., died January 22, while visiting friends, in Providence, R. I. He retired as president of American Bitumuls & Asphalt Co. (sub-



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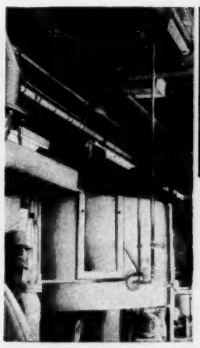
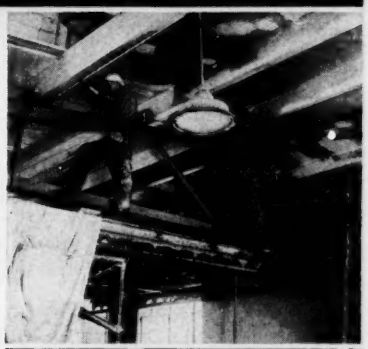
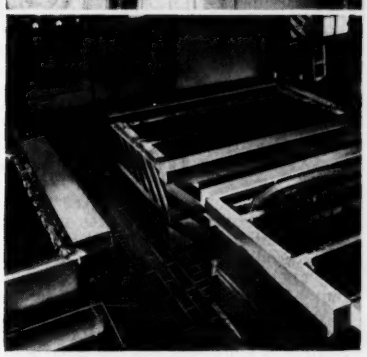


in your plant

you need





Atlas Neoprene Coatings

If yours is a typical plant involved in everyday processing operations, chances are that plant structures and equipment are subjected to continuous corrosive attack.

Whether your problem is the maintenance of ceilings, walls, trenches and structural members, or the protection of processing vessels, fume exhaust systems and storage tanks from a specific corrosive or abusive attack, there is an Atlas Neoprene Coating to do the job.

The Atlas Neoprenes are the result of over 16 years of pioneering in the protective coating field. Through extensive research and expert compounding techniques, Atlas has developed a complete line of tough, flexible, corrosion and abrasion resistant neoprene materials for every coating requirement.

To assist you in the selection of the proper Neoprene Compound to solve your problem, write for Bulletin 7-N.

ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNSYLVANIA

Ask Standard how to cut costs with conveyors

Live roller and gravity roller system handles 55 gal. drums from storage through filling and weighing operations to shipping.

No manpower needed to keep heavy drums moving

STANDARD conveyor systems keep heavy, bulky commodities moving with minimum manpower and time loss. Systems can be job-tailored to any specific materials handling problem — to meet almost any needs.

With more than 50 years of experience in conveyor application, Standard engineers are qualified and ready to help solve your handling problems. Standard builds permanent or portable systems and units, using roller, belt, slat, chain, push-bar or sectional conveyors — power or gravity; also spiral chutes and pneumatic tube systems. Consult STANDARD CONVEYOR COMPANY General Offices: North St. Paul 9, Minnesota. Sales and Service in principal cities.

Cut costs, too, in shipping and receiving operations with Standard portable units, either powered or gravity operated. (Left) HANDIBELT portable powered conveyor unit (right) LITEWATE Sectional Roller Conveyor.

Call the Standard engineer listed in your classified phone book, or write direct for Bulletin 309 — address Dept 0-4

Sales and Service in Principal Cities.

NAMES . . .

sidiary of Standard Oil Co. of Calif.) in 1952.

Arthur Hecker, chemist and former assistant to the vice president of American Cyanamid, died as a result of a fractured skull on January 7. The injury was the result of a fall in his home in Pelham, N. Y.

Helen Miles Davis

Chemist and editor, Helen Miles Davis, 61, died of cancer on January 25 at Suburban Hospital, Washington, D. C.

Since 1944, Mrs. Davis has been the editor of *Chemistry* magazine—a periodical used particularly in the high schools. She also was responsible for editing or writing the following books: "The Chemical Elements," "Scientific Instruments You Can Make," "Atomic Facts," "Science Exhibits," and "Chemistry Show Book." Her compilation of "New Laws of Matter" has run through five editions since its first appearance just after the announcement of the atomic bomb. Throughout her work was an emphasis on the popularization of science, particularly chemistry and the history of science.

Mrs. Davis received her degree in chemistry in 1918 from George Washington University, College of Engineering.

She was the wife of Watson Davis, director of Science Service and editor of the Science News Letter.

Charles Edward Amory Winslow, 79, professor emeritus of public health at Yale University, died January 8,

at the Woodruff Center in New Haven, Conn. Winslow founded the department of public health at Yale, in 1915, and was its chairman for many years.

Ferdinand Breth, 70, vice president of L. Sonneborn Sons, Inc., petroleum refiners and chemical producers, died of a heart attack on January 8.

Raymond E. Kirk

One of the nation's leading chemical educators and dean of the graduate school of Polytechnic Institute of Brooklyn, died at L. I. College Hospital, in Brooklyn, on February 6.

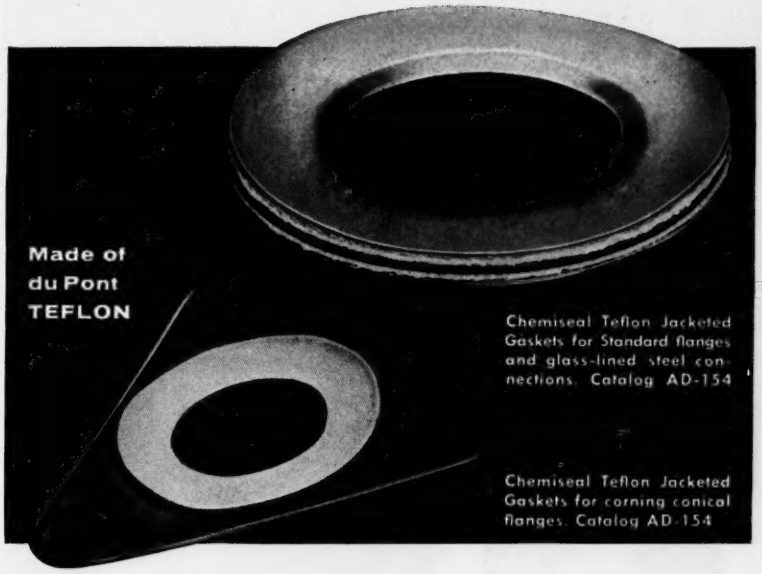
Raymond Eller Kirk, 66, has been head of the department of chemistry at Brooklyn Poly for 24 years. He retired from that position in 1955. For the last 13 years, he also held the position of dean of the graduate school.

Kirk is probably best known, however, as co-editor (with Donald Othmer) of the Kirk-Othmer *Encyclopedia of Chemical Technology.*

During World War I, Dr. Kirk was a civilian inspector of powder and explosives with the U. S. Army's Ordnance Department.

After the War, Kirk taught for a time at Iowa State. Then, in 1920, he began a nine-year stint at the University of Minnesota. For the next two years, he taught at Montana State College and also served as chief of the chemical section of the Montana Engineering Experiment Station.

In 1931, Dr. Kirk began his career at Brooklyn Poly.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Here are Gaskets, Expansion Joints, Flexible Couplings, Adaptors, and Reducers, that will seal against any chemical your process equipment and piping can handle.

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They are designed to protect these costly materials against installation and operating hazards by providing minimum bolt loading, by accommodating thermal expansion, contraction, and misalignment and by absorbing shock and vibration.

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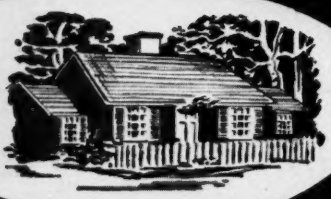

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PEOPLE . . .

FIRMS IN

NEW NAMES

Tri-Point Plastics, Inc., is new name for all divisions of the Tri-Point group of companies, now situated in new, enlarged facilities in Albertson, N. Y.

Stanolind Oil and Gas Co. has changed its name to Pan American Petroleum Corp.

NEW REPRESENTATIVES

Dorr-Oliver has announced the appointment of Kerr Machinery Co., Detroit, Mich., as distributor for industrial and process pumps.

Product Packaging Engineering, Culver City, Calif., has appointed Diedericks & Griffin Co. exclusive Midwest sales representative for PAK-O-VAC plastic vacuum-forming machines.

Braun Corp., Los Angeles, has been appointed Norelco dealer by Instruments Div., North American Phillips Co.

Burrell Corp. has been appointed distributor for Briskeat heating tapes.

NEW FACILITIES

Kimball Mfg. Corp., subsidiary of Bristol-Myers Co., has opened two plants at San Rafael, Calif., to manufacture fibrous glass products.

Tidewater Oil Co. recently announced plans to expand further its 114,000-bbl./day refinery at Associated, Calif., which will boost the firm's western gasoline-producing capacity by 15%.

Lithcote Corp. has leased additional space in Norwalk, Conn., to provide better service to customers using its protective coatings.

Technology Instrument Corp., Acton, Mass. has completed

THE NEWS

M. A. GIBBONS

a $500,000 addition to its plant in Acton. This latest expansion will boost capacity by as much as 100%.

Wyssmont Co., Long Island City, N. Y., has doubled its laboratory and engineering facilities for Turbo dryers, desolventizers and sublimers.

Griscom-Russell Co., Massillon, Ohio, has established a new marine testing laboratory at the Harbor Island, N. C., station of International Nickel Co. to obtain data on heat-transfer and evaporator equipment under actual seawater use conditions.

Dorr-Oliver has announced plans for centralizing all domestic filter manufacturing at its Hazleton, Pa., plant, and expanding capacity of Dorr-Oliver-Long's plant at Orilla, Ont.

Reichhold Chemicals' associate, Resins, Inc., is building a new plant in Manila, P. I., to manufacture synthetic resins.

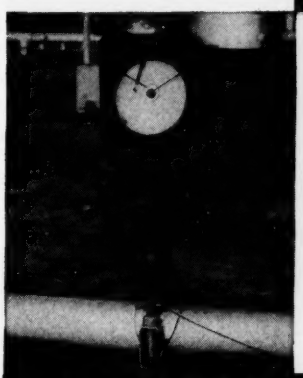
Crown-Zellerbach is building a $31-million paper mill north of Baton Rouge, La. Half of output will go to Time Inc., and C-Z will market the rest in the East and Midwest.

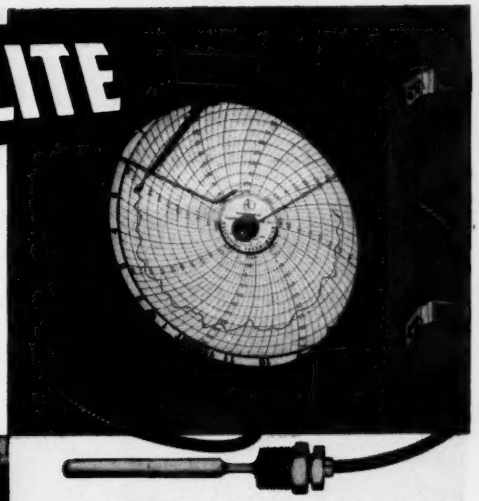
Gulton Industries has established a new division to do research, development and production in the fields of

AUTO-LITE

...for TEMPERATURE RECORDING...

One of the many uses for Auto-Lite Recorders is the application shown below... a natural gas field meter run.





Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
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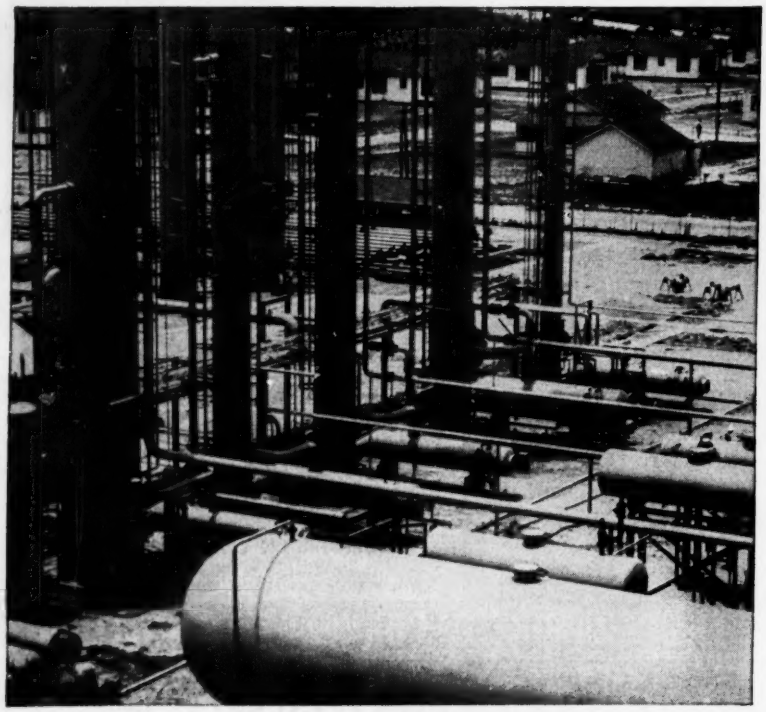
Send for new booklet which describes our operation

Division of The Trubek Laboratories Incorporated

Pipe, fittings and linings of Lead cost much less, give better protection



Federated lead products are the most economical and efficient protection against acids and caustics.

They are less expensive to use because the metal has a high resale value as scrap.

They are more efficient because lead is self-healing. Scratch it in the presence of many acids and a protective coating immediately re-forms. There is no focal point at which corrosion can set in.

Lead is easy to work. It is pliable and can be shaped as required. And it is readily available at moderate cost.

Federated produces chemical lead in sheets made to your specifications. Pipes, bends, traps and other standard fittings are available from stock. Special forms can be fabricated to order.

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FIRMS . . .

high-frequency telemetering systems, ultrasonic dryers and solar furnaces.

Norton Co. recently dedicated its new $2¼-million electric-furnace refractories plant at Huntsville, Ala.

Monsanto Chemical Co. will soon be using natural gas supplied by its subsidiary, Lion Oil Co., which discovered and developed a new gas field near Texas City, Tex.

Texas Co. has scheduled its 40,000-bbl./day Anacortes, Wash., refinery for completion by January 1959.

Borax Consolidated, Ltd., operating subsidiary of Borax Holdings, has acquired new research laboratories at Tolworth in Surrey, England.

Compania Exploradora Del Istmo, Mexican affiliate of Texas Gulf Sulphur Co., has completed construction of an extraction plant at Nopalapa, Veracruz, and is now producing sulfur.

Hagan Chemicals and Controls, Inc. has opened a new Calgon processing and packaging plant at Rockwood, Mich.

Daystrom Nuclear, a dvision of Daystrom, Inc., will establish a nuclear reactor center in West Caldwell, N. J., to train college and university faculty members, and will go into quantity production of 10-kw. Argonaut research reactors for colleges, universities and industry.

Molded Fiber Glass Co. has completed a $100,000 research and engineering building at Ashtabula, Ohio.

Marietta Concrete Corp. is now completing a new plant at Marietta, Ohio, for the production of precast concrete structural members.

Cape Asbestos, Ltd., of London, and its American subsidiary, North American Asbestos Corp., have projected a 50,000-ton/yr. mill and 10,000-

ton/yr. fiber plant for the San Carlos Indian Reservation near Globe, Ariz.

American Smelting and Refining Co., Federated Metals Div., will start building a 72-million-lb./yr. secondary aluminum plant early next year at Alton, Mo.

Kaiser Aluminum & Chemical Corp. has started production of aluminum sheet at the cold-rolling facilities of its new $200-million plant at Ravenswood, W. Va.

Walter N. Boysen Paint Co. has acquired National Lacquer Co. of San Francisco, Calif.

Neville Chemical Co., maker of resins and coal and petroleum byproducts, will spend $750,000 to double research facilities at Pittsburgh.

General Electric Co., operating Knolls Atomic Power Laboratory for the Atomic Energy Commission, will get over $1 million worth of new facilities, including two experimental reactors and an IBM 704 computer.

H. K. Porter Co. has acquired Mullite Refractories Co., Shelton, Conn.

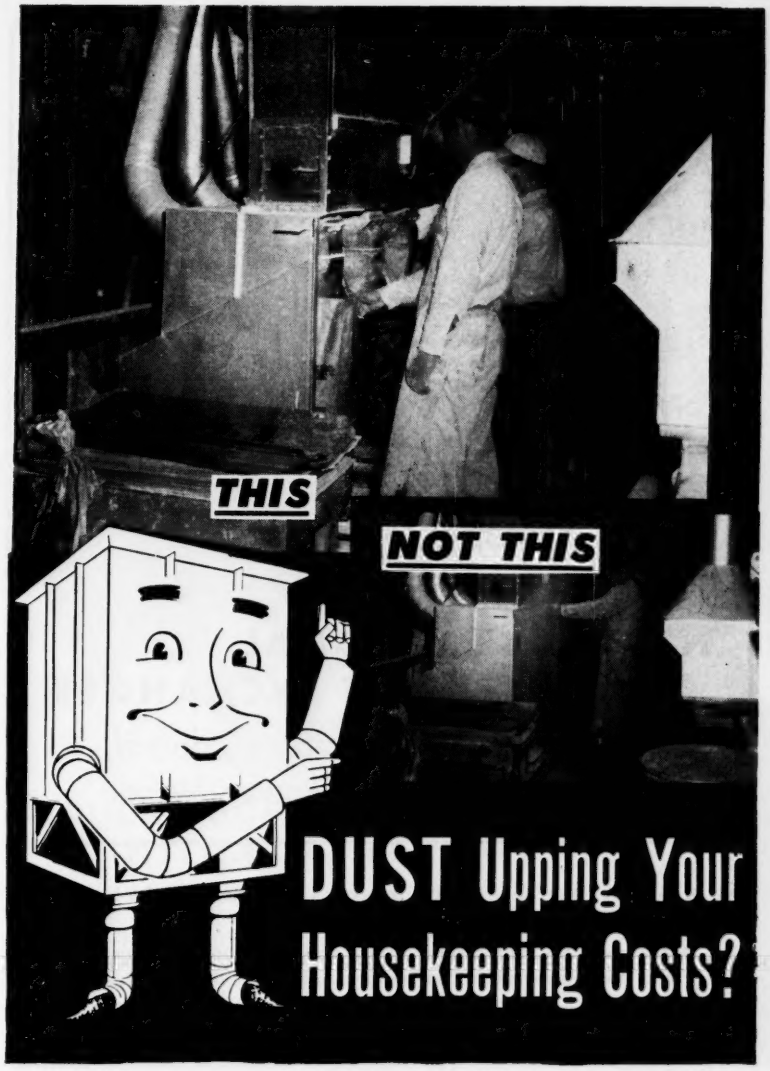
Mission Mfg. Co., maker of chemical equipment and oilfield specialty equipment, will build a more-than-$2-million plant at Houston, Tex.

Whitman Laboratories, Norwich, N. Y., has formed a new equipment division to handle such lines as heat exchangers, homogenizers and centrifugal pumps.

American Potash & Chemical Corp. has opened a $200,000 addition to its Whittier, Calif., research laboratory.

DeVilbiss Co., manufacturer of spray-finishing equipment, has completed a new West Coast headquarters building at Los Angeles, Calif.

Intercontinental Chemical Corp. of New York City, associated



You need Pangborn DUST Control in your plant!

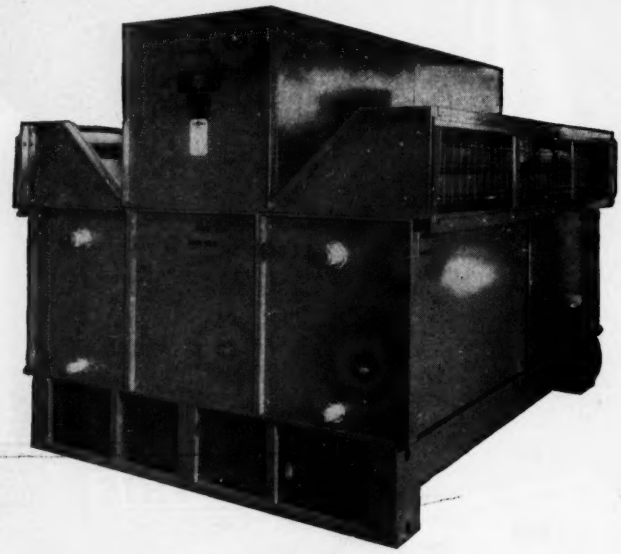
Processing operations in a plant often release dust that settles on floors, walls and equipment. This dust hampers the efficiency of men and machines and makes plant housekeeping a continuing, costly burden.

Pangborn Dust Control stops that. Pangborn Collectors trap dust at the source, clean so thoroughly that in the winter many firms cut heating costs by recirculating the already-heated, cleaned air.

In addition, Pangborn gives you the bonus benefits of longer machinery life, more efficient employees, better employee and community relations and extra profits from any salvage value. Complete line of collectors for all jobs.

Discover how *you* can profit from Pangborn Dust Control—write for Bulletin 922. PANGBORN CORP., 2600 Pangborn Boulevard, Hagerstown, Maryland.

Pangborn CONTROLS DUST



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***Aero* HEAT EXCHANGER**
gives close temperature control, saves you ***LABOR,*** *Power, Water*

- **Because the new design improves the heat transfer to the out-door air by evaporation.**
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You get faster, more accurate cooling of industrial fluids to specified temperatures.

You improve your quality of production by removing heat at the rate of input.

You save labor in upkeep. With full access to all interior parts and piping you see everything in easy inspections. You head off dirt accumulation and corrosion. Casing panels are removable without moving the coils. The coils can be cleaned from both sides.

First cost is low; freight is low because of the lowest space/weight ratio; you save much labor in erection. Capacity range is 7,000,000 to 18,000,000 Btu/hr. No other heat exchange method gives you so much saving in money and convenience.

Write for Niagara Bulletin 132. Ask for the full story of how you can save expense in your plant and improve your product's quality.

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NIAGARA *Over 40 Years' Service in Industrial Air Engineering*

FIRMS . . .

with Farbwerke Hoechst, has purchased majority interest in Carbic Color & Chemical Co., New York.

Fischer & Porter Co., process instrumentation manufacturer, has opened an office in the Carib Theater Bldg. in Clearwater, Fla.

Crescent Carbon Corp.'s carbon and synthetic graphite plant, now abuilding near Lancaster, Calif., will soon be in operation.

Pfaudler Co. has acquired Pitmar Corp., Baltimore, Md.

Morningstar-Paisley of Canada, Ltd., has established a new office and warehouse in Toronto, Ont., and will establish warehouse stocks at Montreal, Quebec.

British American Oil Co. has awarded Lummus Co. of Canada a contract to construct a 6,000-bbl./day catalytic reformer at B-A's Edmonton refinery. Construction will start early next summer.

Alco Products, Inc., has acquired a 107-acre industrial site in Houston, Tex., as eventual production center for petroleum-industry equipment.

Allied Paper Corp. is constructing a semichemical pulp mill at Kalamazoo, Mich. Project will take 18 months and will cost from $4 to $7 million, depending on whether capacity will be 100 or 200 tons/day.

Adolph Plating, Inc., specializing in cadmium, zinc and copper plating, has begun operations in its new $500,000 plant in Chicago.

Polymer Corp., Canadian government has confirmed, will build a $30-million synthetic rubber plant near Red Deer, Alta.

American Machine & Foundry Co. has acquired J. B. Beaird Co., Shreveport, La., maker of LPG distribution systems,

package compressors and pressure vessels, and the W. J. Voit Rubber Corp., Los Angeles.

Pennsalt Chemicals has completed a major plant addition at Calvert City, Ky., to produce Isotrons—the company's new line of aerosol propellants and refrigeration gases. A second Isotron unit is under construction.

Titan Chemical Industries, Inc., recently formed Colorado corporation, will build a plant in the Denver-Boulder area to manufacture aerosol-packed items.

Ethyl Corp. has begun site preparation for its new plant in Pittsburg, Calif. To be completed next summer, the plant will be Ethyl's fourth in U.S. and Canada for producing tetraethyl lead.

Du Pont Co. will build a sulfuric acid plant on the Detroit River at Ecorse, Mich., about eight miles south of Detroit.

Apache Powder Co. is adding an ammonia synthesis plant to its explosive works at Curtiss, Arizona. Girdler Co. will design and engineer the new $1-million facilities.

Western States Refining Co. now has on stream a 1,000-bbl./day Houdriformer at its North Salt Lake City, Utah, refinery.

National Lead Co.'s Titanium Alloy Mfg. division will expand its Niagara Falls zirconium facilities to boost production of zirconium oxide and silicate.

Dow Chemical Co. is building terminal distribution facilities at Grants, N. M., to serve uranium producers in the Southwest.

Air Reduction Pacific Co. has launched construction of a $7.5-million air separation and liquefaction plant at Bassett, Calif. Plant is scheduled for completion late this

REDUCE YOUR PACKING INVENTORY WITH R/M "VERSI-PAK"®

R/M "versi-pak" allows you to drastically reduce your packing inventory, because you can use it on many types of pumps against a wide variety of fluids. Although primarily designed for oil and solvent service up to 350°F and 600 psi, it is highly effective for service against water solutions, weak acids and caustics.

R/M "versi-pak" is a nonjacketed plastic packing composed of selected asbestos fibers in combination with special binding materials and lubricants. It is dense and relatively inert. Its high compressibility provides positive sealing at high pressures yet maintains relatively low pressure at the packing gland. The surface is free of loose materials, and there is no excessive loss of lubrication during service. The rectangular cross section, besides giving greater handling strength, reduces the number of rings required per set.

This packing is available in two formulations: No. 1845, a black, graphited type for general use; No. 1846, white and nongraphited, for use in food handling and other special services. Both types are furnished in spiral and butt-cut rings, sizes 1/8 to 1 in., in increments of 1/16 in.

For complete information on R/M "versi-pak," write for this booklet today.

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS — including Vee-Flex, Vee-Square, Universal Plastic, and "versi-pak"®; GASKET MATERIALS, "TEFLON"* PRODUCTS. SEE YOUR R/M DISTRIBUTOR.
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MECHANICAL PACKINGS AND GASKET MATERIALS

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this is what we need
and here's why

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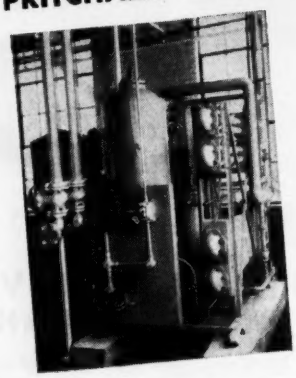

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Kansas City 12, Missouri

FIRMS . . .

year, will produce 55 tons/day of liquid oxygen, 15 tons/day of liquid nitrogen and 3½ tons/day of liquid argon.

Southern Nitrogen Co. has started production at its new $14-million nitrogen plant at Savannah, Ga.

Sulphide Corp. Pty., Ltd., Melbourne, Australia, will build a new zinc smelter and boost output of sulfuric acid and superphosphate near Newcastle, New South Wales. New Facilities will use sulfur content of Broken Hill zinc concentrates which would otherwise be exported.

Continental Oil Co. will build a $1.75-million natural gasoline plant south of Oklahoma City, Okla. Plant will have a capacity of 60 million cu. ft./day.

Standard Oil Co. (Ohio) has awarded M. W. Kellogg a contract to build a $34-million refinery at Toledo, Ohio. Construction begins this month and the refinery will be on stream in April 1958.

Thiokol Chemical Corp., Trenton, N. J., has acquired National Electronics Laboratories of Washington, D. C.

Valve Corp. of America, Bridgeport, Conn., is planning to boost production by 50% at its main plant in Bridgeport.

Beckman Instruments' Berkeley Div. will triple production capacity at its Richmond, Calif., plant, through a $1.5-million expansion plan.

International Paper Co.'s Bagpak Div. is constructing a new multiwall paper shipping-sack plant at Litchfield, Ill., to be in operation late this year.

U. S. Oil & Refining's new 2,500-bbl./day Houdriformer at its Tacoma, Wash., refinery is slated to go on stream this summer.

Gulf Oil Corp. will exercise its option to buy land near

Charleston, S. C., with tentative plans for a $120-million, 120,000-bbl./day refinery.

National Vulcanized Fibre Co., Wilmington, Del., has opened a new district office in Dallas, Tex.

Food Research Laboratories, Inc. has established a western branch in Los Angeles, with a laboratory for nutritional, toxicological and pharmacological investigations.

Corroplast, Inc., has begun operations at its Passaic, N. J., plant to produce extruded, unplasticized rigid polyvinyl chloride pipe, duct and sheet.

Sentinel Glass Co., process equipment distributors, has added warehousing facilities to its Hatboro, Pa., plant. Facilities will be used for borosilicate glass pipe, heat exchangers and columns.

Ferro Corp. has acquired American Clay Forming Co., Tyler, Tex., makers of ceramic clayware products.

Shell Oil Co. has plans for a $1-million expansion to the recently announced Wilmington-Dominguez, Calif., refinery building program.

Magnaflux Corp. has just completed an addition to its main plant in Chicago to meet demand for its nondestructive testing systems.

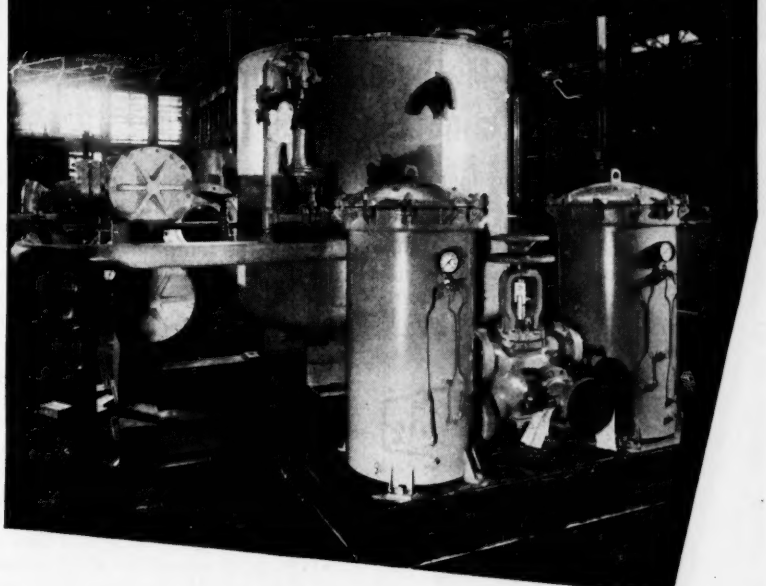
Woodbury Chemical Co., St. Joseph, Mo., has purchased the buildings and property of the Brancucci Chemical Co., Denver, Colo.

NEW COMPANIES

Sole Chemical Corp., Chicago, has been organized as a chemical marketing organization. The firm will base its organic-specialty sales program on customized technical service to manufacturers of surface-active agents.

Gillock Chemical Co., Texas City, Tex., has been formed by the chemical operations of

No Foreign Matter Larger Than 2 Microns in this compressor lube oil system



...It's NUGENT Filtered

The photo above shows an Allis-Chalmers lube system package consisting of pump, cooler, filter, tank, and console for a centrifugal compressor being readied for shipment to a southwestern petrochemical plant. In the foreground is the Nugent 1555 BF-4L7 Duplex Lube Oil Filter which protects the lube oil used in the compressor.

This large capacity duplex full flow filter consists of two parallel filters with a flanged switching valve supported between them. Each filter is equipped with a three-way cock and differential pressure gauge and has a capacity of 225 GPM of 150 SSU viscosity lubricating oil at about 5 psi pressure drop. They may be operated independently or in parallel.

Filter recharges are laminated, crenulated fiber disc type, providing 20 times more filtering area than other filters of comparable size. The recharges have a useful life 4 to 10 times that of other types and are expendable.

Nugent Full Flow Filters will remove foreign solids as small as 2 microns from lube or fuel oil before they can reach and damage vital precision parts. Give your engines and compressors the advantage of Nugent Full Flow Filtering — they'll reward you with longer trouble-free service.

Write for free descriptive literature, outlining your filtering needs.

Laminated crenulated fiber disc cartridge used in the Nugent Duplex Full Flow Lube Oil Filter.

Established 1897

Wm. W. Nugent & Co., Inc.

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USEFUL INFORMATION ABOUT REACTIVE CHEMICALS FROM DU PONT ELECTROCHEMICALS DEPARTMENT

Versatile Methylene Chloride Chases Paint and Bugs Too

With a fortunate combination of properties, including high solvent power for many organic compounds —both those of non-polar and polar nature—methylene chloride finds its way into many seemingly unrelated applications in a wide variety of industries.

For instance, the paint and varnish industry uses methylene chloride as the major constituent of highly efficient nonflammable paint remover. In combination with additives, such as wetting agents and evaporation retardants, it has been found very effective on a wide range of finishes including the newer resins.

In the packaging field, methylene chloride plays an important role. In the low-pressure aerosols used to disperse insecticides, deodorants, etc., it serves as both a diluent for the more powerful propellents and as a solvent for the concentrate. This solvent action helps minimize the danger of plugging the dispensing nozzle.

But methylene chloride has many other uses . . . it is used in the manufacture of safety-type photographic film, in cleaning compositions, as a solvent for cloth, paper and leather coatings, and in refrigeration and air conditioning installations. If you would like to know more about the applications of this versatile hydrocarbon, just check and mail the coupon below.

Formaldehyde—The Chemical Button

Formaldehyde is one of the most reactive organic chemicals. It reacts with a wide variety of organic and inorganic compounds to make many interesting and useful derivatives. It takes part in many reduction, addition, condensation, and polymerization reactions. Its methylene ($-CH_2-$) group functions as a "chemical button" to link similar or dissimilar molecules.

High purity 50% and 37% formaldehyde is available at low cost from Du Pont. For more information about its properties, just check the coupon below.

E. I. du Pont de Nemours & Co. (Inc.)
2526 Nemours Bldg., Wilmington, Del.

Please send me literature and information on: (CW-12)

- ☐ Methylene Chloride
- ☐ Sodium
- ☐ "Elvanol" Polyvinyl Alcohol
- ☐ "Albone" Hydrogen Peroxide
- ☐ Formaldehyde

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. . . THROUGH CHEMISTRY

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"Albone" Gives Modern Furniture a Beauty Treatment

The modern taste for light-colored woods in contemporary furniture poses its own special problems for the furniture manufacturer. Here, "Albone" hydrogen peroxide plays an important role in securing these distinctive finishes.

"Albone" and "Albone" bleaching solutions are applied usually by spraying, although brushing, wiping or dipping, are sometimes used. The bleaching process requires the application of alkali and peroxide on the surface of the wood. For simplified operations, the two are applied as a single solution. They may also be applied separately.

Currently, bleaching is being used to obtain a light base wood, which is then stained or toned to produce uniform, light, natural colors. In this way, the natural beauty of the wood grain is retained.

Finishing problems associated with wood bleaching are solved by the use of proper drying cycles, neutralizing and/or reducing agents. Many of the leading furniture manufacturers are using "Albone" to help them produce the light, natural finishes now in vogue.

For more complete details regarding solutions, methods of application and safe handling of "Albone" fill in and mail the coupon on the left.

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Tough Greaseproof Protection for Paper from "Elvanol" Polyvinyl Alcohol

Tough, flexible films that find many uses on paper products can be produced from solutions of "Elvanol" polyvinyl alcohol. "Slush-coating" of fiber drums, for example, produces a rugged, greaseproof coating ideal for the packaging of oily or greasy materials.

Completely hydrolyzed grades of "Elvanol" form excellent greaseproof coatings for packaging nuts, doughnuts, cookies, etc. Durable coatings are easily applied, provide a protective barrier against air—so important in food wrapping—and take customary folds, creases and hard wear without cracking.

For more ideas on how it can be put to work for you, simply fill out and mail the coupon today.

Sodium Reduction of Fatty Acid Esters

For the production of an almost countless number of useful alcohols from plentiful fats and oils, an improved general method has been developed for reducing esters by means of metallic sodium. Practically quantitative yields of alcohols, based on both sodium and ester, are obtained, especially from fatty acid esters of higher molecular weight. The improved method uses theoretical amounts of both sodium and reducing alcohol and the reaction is carried out in an inert solvent, such as xylene or toluene. The method is especially applicable to the preparation of unsaturated alcohols not easily made by catalytic hydrogenation. It compares favorably with catalytic hydrogenation of saturated, higher fatty acid esters because of the simplicity of operation and equipment, and it can be carried out at ordinary pressure.

For more details of this sodium reducing process, check the handy coupon to the left.

FIRMS . . .

American Oil Co., Standard Oil (Ind.), and Stanolind Oil Co.

Selas Corp. of America has formed a European subsidiary, Selas Corp. of America, European Div., S. A., with headquarters in Geneva.

Arthur D. Little Research Institute has been formed in Great Britain to undertake fundamental research for clients. The new organization is sponsored by Arthur D. Little, Inc.

Reactive Metals, Inc., has been formed by National Distillers Products Corp. and Mallory-Sharon Titanium Corp. New firm initially will be engaged in melting zirconium and its alloys.

Oleochim, S. A., newly formed by Archer-Daniels-Midland and Palmafina, subsidiary of Petrofina, will build a plant in Brussels, Belgium, to make fatty acids and their derivatives.

NEW LINES

American Cyanamid Co. has expanded its line of organic phosphate insecticides to include methyl parathion technical, to be used in making emulsifiable liquids, wettable powders and dusts.

Garlock Packing Co., Palmyra, N. Y., has introduced a complete selection of silicone rubber packing materials.

Crown Central Petroleum Corp. has begun marketing a new high-octane gasoline from Texas to New England.

NEW LOCATIONS

Alconox Inc. is moving all executive and sales offices to 853 Broadway, New York, N. Y.

Gardner-Denver Co., manufacturers of pumps and air compressors, has moved to 4309-11 Rising Sun Ave., Quincy, Ill.

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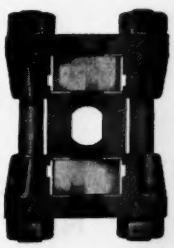

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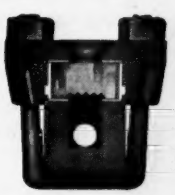

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When chlorine in dry gaseous form is required in relatively large quantities, Whitlock Vaporizer Systems provide high capacity output at low equipment cost. The Systems, whose design and construction were suggested by the standards of the Chlorine Institute, Inc., are standardized in design and complete packages in themselves. To operate, it is only necessary to connect steam, condensate, chlorine, and vent lines, and to insulate as required. The five standard sizes handle liquid loads in the range of 500 to 8,000 pounds per hour and provide compact, economical units for efficient operation on any installation. The controls are simple, reliable, and safe. . . . .

AUTOMATIC SYSTEM NOW AVAILABLE

New automatic controls now adapt the standard Chlorine Vaporizer System above to automatic operation. Pressure reducing valves maintain constant pressures in steam and downstream chlorine lines . . . and automatically adjust the input of liquid chlorine to compensate for fluctuations in the downstream load. Controls are wholly automatic and relieve operator of all responsibility for manually adjusting any valves for flow control.

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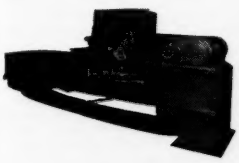

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P. O. Box 12
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Chemical Engineering

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APRIL 1957

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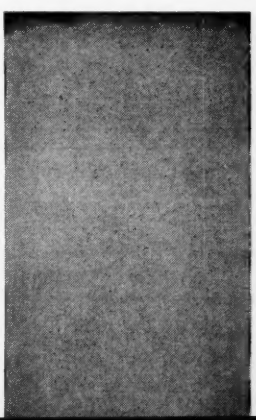

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Nuclear Engineers. To direct reactor experiments, supporting research and development work, and to evaluate all reactor hazard proposals for the AEC, Washington, D. C. $5,000-$12,000. Requires B.S. in Ch.E., E.E., M.E., Met.E., Aero.E., Physics, with progressive experience in the design, construction, and operation of reactor systems. Contact John E. Uhrlaub, USAEC, Wash., D. C.

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Manufacturer of Heat-Transfer apparatus & pressure vessels required additional sales representation in East. Contacts in Chemical Plants. Marine, oil refineries and power plants desirable. RW-1952. Chemical Engineering.

Manufacturer's Representatives and Distributors—wanted to handle sales and service of miniature (¼ H.P. up to 5 H.P.) electric steam generators up to 100 lbs. pressure—each unity bearing a Registered National Board of Boiler and P.V.I. Number, individually inspected under the miniature boiler code. We have specialized in this field for 10 years and desire only men who know and work with steam, or equipment requiring steam for its operation. Please reply RW-4363, Chemical Engineering.

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Salaried Personnel $5,000-$35,000. This Confidential service established 1920, is geared to needs of high grade men who seek a change of connection, under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L. P.O. Box 674, Manchester, Vermont.

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Graduate Chemical Engineers with 3-5 years experience in chemical, petro-chemical, or related fields. Position involves design of process improvements and economic evaluation, involving organic and inorganic chemical processes.

Graduate Chemical or Mechanical Engineers with approximately 2-5 years experience for process work in operations and plant start-up. Must have initiative and ability to grow with an expanding organization.

Salary commensurate with experience and ability. Send complete resume of education and experience to:

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P. O. Box 686, Pasadena, Texas

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Opening for SENIOR PROJECT ENGINEER created by announced expansion of company's production facilities at Henderson, Nevada, (located 11 miles east of Las Vegas, Nevada).

B.S. or M.S. in Chemical Engineering with minimum of 5 years experience in chemical process design or construction field.

Responsible for chemical equipment design and selection; construction scheduling; liaison between engineering, production and construction forces; approving design by contractor's engineering groups; and final field acceptance of completed installations.

Processes are production of titanium tetrachloride and titanium sponge, but previous experience with these processes is not necessary.

Salary commensurate with ability, experience, and education.

Send resumes to:

INDUSTRIAL RELATIONS DEPARTMENT
TITANIUM METALS CORP. OF AMERICA
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Ph.D.—recent graduate or experience in food research or development preferred. Experience in related organic fields acceptable. Openings in Minneapolis. Excellent future with multi-plant firm. Employer pays our fee and expenses. Send resume and recent photo to H. A. Jensen.

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To execute process investigations and pilot experiments. Man with B.S. or M.S. degree and up to four years experience preferred. Send complete resume to:

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SALES MANAGER

Aggressive man to handle sales, field engineering and distributor organization for company manufacturing shell and tube heat exchangers. Midwest location. Should have B.S. degree or equivalent in engineering. Give full particulars and salary requirement in reply. Include recent photo.

P-4340, Chemical Engineering,
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Company Pays All Fees and Other Expenses.
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The Engineering Service Division of du Pont's Engineering Department provides consulting service and technical assistance to production, maintenance, design, research, and constructive groups within the company. The Division's objectives are to assist other company units in improving plant efficiency and product quality, in reducing investment and operating costs, and in increasing capacity.

Six openings are immediately available for experienced graduate engineers to provide consulting service to operating plants in the following specialized chemical engineering fields:

PETROCHEMICAL ENGINEER

Successful applicant will analyze existing and proposed chemical processes for utilization of petroleum processing equipment and methods for obtaining greater yield and lower equipment investment, particularly with respect to hydrocarbon processes. Typical operations to be evaluated include solid fluidization, absorption, reforming, and catalysis. This requires broad familiarity with equipment such as hypersorbers, distillation columns, cracking furnaces, low temperature refrigeration systems, and compressors. Other duties include trouble-shooting and economic evaluation of alternative processes and equipment.

PLASTICS ENGINEER

BS engineering or chemistry, minimum. 5-10 years' experience in plastics engineering for process equipment and auxiliary services. Duties include consulting services covering development, evaluation, selection, specification and fabrication of plastics for chemical process equipment and auxiliaries; investigatons of failures and recommendations of remedial measures.

WATER ENGINEER

The desirable background will include extensive experience in water procurement and treatment for industrial plants. Knowledge of water treatment plant operation through practical experience is important. The successful applicant will provide engineering advice to those designing, constructing and operating company plants on problems involved in the procurement and treatment of industrial water supplies.

INSTRUMENTAL MEASUREMENT ENGINEER

Graduate engineer experienced in research, application, consulting or development of techniques for process variable measurement. Duties will include trouble shooting, consulting and technical assistance in application of IR and UV spectroscopy to automatic analysis of chemical process fluids, and instrument application in viscosity, temperature, pressure, flow and other process variable measurements.

AIR CONDITIONING ENGINEER

BS in ME or equivalent minimum. At least 5 years' experience in analysis, design and development of industrial and comfort air conditioning and ventilating systems, particularly in equipment selection and performance, controls, practical layout and economics. Duties include consulting for Engineering and Plant Operations groups, and liaison with Company and outside personnel and organizations. Travel to plant and other locations required. Engineer should be articulate in speech and writing. Must be able to function with minimum supervision, to accept responsibility and to show mature initiative. Personal traits should fit man for dealing with people, and for developing to position of prominence in field.

PUMPS & FLUIDS

Desired qualifications will include extensive engineering knowledge of and familiarity with equipment used in the fluid mechanics field. Development, research, design, maintenance, or teaching experience with pumps, compressors, jets, and seals is desirable. Responsibilities of the position will involve selection of equipment, trouble-shooting, and consultation of fluid flow and mechanical design aspects of piping, pumps, jets, compressors, and seals. Duties include evaluation of available equipment and recommendations for equipment modification for special applications.

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For an appointment, please call	For an appointment, please call	For an appointment, please call
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E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

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Research projects throughout the Jersey Standard interests. These involve the study of terminal operations, transportation, and inventory control problems. Such studies typically mean one or more field trips to collect basic data and to define the problem; analysis of the data to develop "mathematical models" of the problem; close work with the client to incorporate the results of these studies, and finally, follow up on the results.

Give full details of education, experience, desired salary, availability date and references. All inquiries will be considered promptly and held confidential.

ESSO RESEARCH AND ENGINEERING CO.

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Esso Research Center

Employee Relations-C

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Send Resume to

THE EIMCO CORPORATION

Process Engineers Division

420 Peninsular Ave. San Mateo, California

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Opening on Chemical Engineering's editorial staff for a young engineer to develop, evaluate and edit engineering articles. Unusual opportunity to broaden experience, education and contacts. Requirements: Degree in chemical engineering with sound training in fundamentals; 1-5 years industry experience; ability to analyze technical information accurately, to organize it logically and to explain it clearly. New York City location. Send resume and salary requirements to:

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Engineering Research Department
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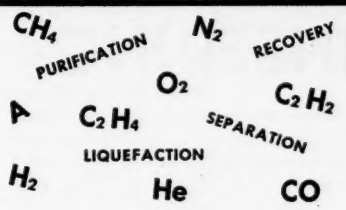

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- DESIGN ENGINEERS
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Air Products
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PERSONNEL DIRECTOR
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330 W. 42ND ST.
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Letter should give full details of education, experience, salary desired, availability date and references.

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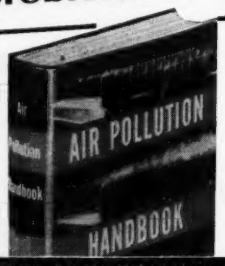
For the answer, turn to page 331

To Help You analyze and solve AIR POLLUTION problems



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1—Stokes 2' x 6' Rotary Vac. Dryer.
1—Albright Neil 4' x 9' Atoms. Drum Dryer.
1—Buffalo Vac. Drum Dryer 24" x 20".
Vac. Shelf Dryers & Kilns.

CENTRIFUGALS & CENTRIFUGES

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8—Centrifugals 12", 30", 40" & 48" Steel, Copper, Stainless & Rubber Lined.
6—Sharples Centrifuges #5A Stainless. Also #6.
3—De Laval Multiple Clarifiers #200, 300 & 301.

FILTERS

#2 Sweetland Filter 12 Stainless Covered leaves.
1—Vellez 41 Stainless Covered Leaf Filter, types 49.
1—Ertel Eng. 10 Disc Filter Nickeled Bronze.
Sperry & Shriver 7" to 36 sq. in. Iron & Wood.
Gen. Amer. 2" x 1" Rotary Vac. Filter.

KETTLES & TANKS

Pfaudler 200 gal. Glass Lined Closed Jack. Kettle.
1—Dopp 350 gal. C. I. Jack. Vac. Kettle.
Devine & Stokes Impreg. Units 30" & 36" dia.
Devine 1000 gal. closed jack. Steel Kettle.
1—2300 gal. Vert. agit. Jack. Steel Kettle.
8—Jacketed Kettles 50 to 2300 gals.
1—250 gal. Lead Lined Kettle.
Pfaudler 150 gal. closed agit. Jack. Steel Kettle.
50—Stainless Alum. Copper, Glass & Lead Lined Kettles & Tanks. Also new Stainless.

PULVERIZERS & MILLS

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Pebble Mills 24" x 30", 30" x 30", 30" x 34", 30" x 42", 4' x 5'. Also Jar Mills.
1 Raymond Automatic Pulverizer 20 H.P. motor.
1—Raymond #00 Pulverizer 30 H.P. Complete.
2—#0000 Raymond Mills.
Sturtevant #0 18" Hinged Hammer Mill.
Sturtevant Lab Swing Sledge Mill.
Jeffrey 18" x 18" Single Roll Crusher.
Day Hercules Spike Crusher 1½ H.P. motor.
Hammer Mills Pulverizers 3 to 50 H.P.
1—Shultz O'Neil 20" Pulverizers. Also #1.
Williams #3 & 2xx Hammer Mills.
1—Robinson 18" & 22" Attrition Mill.
1—Lehman 4 Roll W. C. 12 x 36" Steel Mill.
3—Steel 3 Roll Mills 9"x32", 12"x30" & 16"x40".
3—Houchin 18"x36"; 4 Roll Granite Stone Mills.
Ball & Jewell Rotary Cutters Lab. & up.
2—U. S. & Premier 1½ H. P. Colloid Mills

MIXERS & SCREENS

Day Imperial 75 & 150 gal. Jack. Mixers.
Baker Perkins double arm 100, 50 & 9 gals.
2—Read 50 & 100 gal. double arm mixers.
Lancaster 6' dia. vert. Mixer 25 H.P.
Kent 3 H.P. Continuous Dry Mixer.
Horiz. Mixers single & double arm to 200 gal.
3—Day 8, 15 & 40 gal. Pony Mixers.
2—Day Brighton 20 gal. Change Can Mixers.
Read 40 and 80 qt. vertical Mixers.
6—Lead—Paste Mixers 50 to 150 gals.
Tyler 3'x5' Vibratory 2 Deck Screen. Other sizes.
Blystone 3000# horiz. spiral mixer.
10—Dry Spiral Mixers 50 to 3000#.
12—Portable Elec. Agitators ¼ to 5 H.P.

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Rotary & Single Punch Tablet Machines, ½" to 4".
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Gould 75 H.P. Centrifugal Pump 250 PSI.
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Filling Machines powder, paste & liquid.
1—Howe Mogul Barrel & Bag Packer.
2—Worthington 12" x 12" x 12" Vac. Pumps.
6—Devine Stokes & Buffalo Vac. Pumps.
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1—Day Mixer steam jacketed, 50 gal. Sigma Blade.
1—Sperry Filter Press 42", open del., 83 plates & frames—like new.
60—New Pressure Cookers, 18"x18" & 24"x28".
1—New Glass Nash Centrifugal Pump, 160 gpm.
1—New Nash Vacuum Pump Type AL-572.
1—Buflovak Jacketed Impregnating Tank 42"x52".
1—Stedman Disintegrator size 40-6.
1—Abbe Ball Mill, 36"x42" Buhrstone lined.
1—Nash Air Compressor, Type AL-623.
1—Manton Gaulin Stainless Homogenizer 125 gph.
1—I&R Vacuum Pump, 5 H.P., 60'.
4—Heat Exchangers, 12" dia. 11' lg., 43 steel tubes.
1—Raymond 8" Hammer Mill, like new.
2—Louisville Steam Tube Dryers 6'x35'.
1—New Louisville Continuous Filtering Machine.
2—Stainless Steel Steam Jacketed Readco Mixers.
1—#316 Stainless Reactor, 265 gals. cap. jacketed.
Abbe Pebble & Tube Mill, 5'x22'—Buhrstone Lined.
1—Patterson Ball Mill, porcelain lined, 17"x27".
1—Patterson Ball Mill, 42x36, jacketed.
2—Large Steam Jacketed Horizontal Mixers.
2—Ribbon Type Mixers, 50 & 90 cu. ft.—like new.
2—Steel Tanks 90,000 gals. ea. vert. welded const.
2—Ball & Jewell #2 Cutters with 75 H.P. Motors.
1—J. H. Day, 3-roll Mill 9x16.
3—3,000 gal. Jacketed Kettles with Turbo Agitators.
1—#10 Day 300 gal. Jacketed Sigma Blade Mixer.
4—New Heat Exc. 60' with Cupro Nickel Tubes.
1—Sparkler Stainless Filter Model 33-S-9.
3—4'x8' Shaker Screens.
6—W & P Mixers, jacketed, heavy duty, sigma blade, 200 gal. with hydraulic dumpers.
3—Baker-Perkins Mixers—same as above.
1—Carver Laboratory Press.

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250 cu. ft. Rotary jkt. SS Blender
C20 Sharples Super-D-Hydrator SS
C27 Sharples Super-D-Hydrator Monel
36" x 50" Bird Cond. Centrifuge
40" SS Bird Sus. Perf. Centrifuge
200 gal. B. P. Wet Churn jkt. vac.
Rotoclone Collector Size 36, Type W
3' x 14' x ¼" steel Column, 75 PSI
4' x 40' x 1-1/16" Steel Column, 470 PSI
Compressor Bury 1600 CFM @ 110#
2350 sq. ft. Condenser, steel/SS
5' x 20' x ¼" Rotary Cooler
30" Robinson Rotary Cutter, 30 HP
502-16 L.B. Roto Louvre Dryer
705-20 L.B. Roto Louvre Dryer, SS
705-24 L.B. Roto Louvre Dryer
3000 CFM Lectro Dryer, Type CHR
8'6" x 35' Rotary Dryer
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243D Stokes Oscill. Granulator
6' x 8' Abbe Ball Mill GPH, unlined
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3620 DIXIE-Non Clog Hammermill
Penn. Impact Crusher w/50 HP motor
Micro Pulverizers 2TH & 1W
Case Packer-Std. Knapp 6/1 gal. cans
412G Stokes Microvac (NEW)
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Baker Perkins 625 gal. Cascade Mixer in Type 316 Stainless; continuous.

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Zaremba Double Effect INCONEL Evaporator with Calandria; 430 sq. ft.

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3—Bird 32 x 50 Solid Bowl Centrifugals, Type 316 Stainless Steel, fume-tight. 60 HP motor. Built 1953
1—Bird 36" x 50" Solid Bowl, Steel
1—Bird 40" x 60" Solid Bowl, T304 Stainless steel
4—DeLaval Nos. 74-11; 94-01; 600
2—DeLaval #BUH-3930 Hermetic Clarifiers, Stainless Steel
2—Sharples Super-D-Hydrators, C-20 & C-27, St. St.

DRYERS

3—All stainless steel Vacuum Shelf Dryers, 108 sq. ft.
1—Devine #27 Vacuum Shelf, 475 sq. ft.
1—Devine #23 Vacuum Shelf, 356 sq. ft.
2—Devine Vacuum Shelf Dryers, size 17, 80 sq. ft. UNUSED.
1—Buflovak "C" Vac. Shelf, 55 sq. ft.
1—St. St. Spray Dryer, 19' dia. x 20' high, with Western Precip. nozzles, fans, oil burners, etc.
1—Bowen St. St. Laboratory Spray Dryer
1—American Double Drum Vacuum Dryer, 36" x 84"
7—Double Drum Dryers; 42" x 120"; 42" x 100"; 32" x 52"; 24" x 60"; 22" x 38"
4—Rotary Hot Air Dryers: 4'6" x 40'; 4'6" x 32'; 3'6" x 25"; 3' x 24'
3—Rotary Coolers: 104" x 30'; 104" x 70'; 5' x 40'
1—B & S Rotary Hot Air Dryer, 3' x 15', Everdur (Silicon Bronze)
2—Stokes Jacketed Rotary Vacuum Dryer 3' x 10', 3' x 15'
1—Buflovak Jacketed Rotary Vacuum Dryer, T316 St. St. 3' x 10'
2—Rotary Steam Tube Dryers: Louisville 6' x 30' and Ruggles Cole 4' x 30'
2—Davenport size 2A Dewatering Presses
2—Swensen Walker Crystallizers steel, jacketed, each 30' long

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1—Ozark-Mahoning Submerged Combustion Evaporator, type 316 stainless steel, 2,800,000 BTU/Hr.
2—Bartlett Snow St. St. Jacketed Evaporating Kettles 6' dia. x 3' deep with heavy duty agitator and 25 HP 4-speed drive
1—Conkey 1900 sq. ft. Triple Effect, Evaporator Vertical long Herculoy tubes
1—Buflovak size 6.5 model 629D Double Effect, all stainless steel, 588 sq. ft.
3—Stainless Steel Dairy type 6' dia. Vacuum Pans with coils
1—Struthers-Wells Single Eff. St. St. 625 sq. ft. vertical tubes
1—Stainless Steel 145 sq. ft. coil, 500 gal.
2—150 gal. Jacketed Vacuum Pans or Still 1—St. St., 1—Monel
1—Stokes type 316 St. St. Double effect water still, 250 GPH
8—Copper Bubble Cap Distillation Columns 24" dia. to 48" dia.
4—Stainless Steel Packed type Columns 8" dia. to 24' dia.

AUTOCLAVES—REACTORS

6—465 gal. St. St. 3' dia. x 8'6" deep, 150# WP, 165# jkt. pr.
1—1420 gal. St. St., 4' dia. x 15' deep, 200# WP, 85# jkt. pr.
3—Pfaudler Glass Lined, jktd. & agit. 30 gal., 50 gal. & 100 gal.
3—St. St. T347, 13 gal. 1400# test, 50# jkt.

FILTERS

1—Niagara Model 510-28-type 316 Stainless Steel Filter, 510 sq. ft.
2—Sparkler #33-S-28 Filters, Steel Tank, St. St. plates
1—Feinc 6'6" D x 6' Face String Discharge
2—Eimco 10' x 12' Rubber Covered Filter
2—Sweetland Filters: #12 (12 lvs.); #5 (20 lvs.)
5—Cast Iron Filter Presses, 30" x 30" open delivery, 28, 35, and 50 chambers
5—Filter Presses, closed delivery, 7"—36"

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Attrition Mills — Jaw Crushers
Comminuting Machines—Pebble Mills

Send us your inquiries—write for detailed list

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1—Conical Blender, Steel, 6' dia.
3—Sprout Waldron size 12 Ribbon Mixers, 336 cu. ft. work. cap.
3—Day Stainless Steel Sigma Blade double arm jacketed mixers, 5 gal., 50 gal. & 75 gal.
1—Day 200 gal. Stainless Steel Sigma Blade Non-jacketed Mixer
3—Sigma Blade Double Arm Jacketed Mixers, 2¼ gal., 50 gal. & 100 gal. work. cap.
4—Side Entering Stainless Steel Mixers, 15 HP & 25 HP
3—Falk Vertical Agitator Drives #10-GDX, 10:1 300 HP—UNUSED
5—Turbo Vertical Drives, #5B, 5:1, 40 HP

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Stainless Steel
New in 1951—Expl. Pr. Motors

1—KACR Reactor, ser. #3127
1—Kom-Bi-Nator, 200 GPH #3114
1—AC-500 Homogenizer, #3125
2—Roto-Feed Mixers, #3129, 3130
1—DP-Dry Proportioner, #3131

TANKS

3—Aluminum 18,000 & 24,500 gal.
12—Aluminum, 3000 gal. 5 compart.
10—Aluminum, 500 gal. 80# WP.
1—St. Clad, T304, 3/8"; 6500 gal. Vert.
10—St. St. Pressure Tanks—to 4000 gal.
20—St. St. Storage Tanks—to 1000 gal.
1—St. St. Oval Tank, 2500 gal.
1—3500 gal Glass Lined Jacketed Tank

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Baker Perkins 50 gal. Steel and Stainless Steel Double Arm Jacketed Heavy Duty Mixers with Stainless Jacketed Blades.
3500 gallon working capacity Steam Jacketed Double Arm Mixing Tanks.
Day 4000 lb. Jumbo Dry Powder Mixer.
Stokes, Day, New Era, Hottman Mixers, from 2 to 450 gal., with and without Jackets, Single, Double Arm Agitators.
Baker Perkins, Day Readco Heavy Duty, 1 qt. to 160 gals., Double Arm Jacketed Mixers with Sigma or Fish Tail Blades.

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Knapp Wraparound Labeler.
CRCO Nu-Way Wraparound Labeler.
Resina LC and Elgin Cappers.
Burt 611AUB Wraparound Labeler, to gal.
Pony M, ML, World, Ermold, Pneumatic Semi and Automatic Labelers.
Capem 4-Head Automatic Capper.

FILLERS

MRM and Elgin Rotary Fillers.
S. & S. G1, G2, G6, HG84 Fillers.
MRM S. A. Stainless Steel Vacuum Fillers.
Triangle Elec-Tri-Pak Fillers, 1 to 6 Head.
Elgin 5-Head, Hope 1, Filler 2 and 4-Head Stainless Steel Piston Fillers.

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Pneumatic Scale Packaging Units with high speed Carton Feeders and Bottom Sealers, Weighers, Top Sealers with Compression Units, Carton Liners.
Transwrap Auto. Bag Machine.
Miller, Hayssen, Package Machinery, Oliver, Campbell, Transwrap Wrappers.
Standard Knapp 429 Carton Sealers.

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Fitzpatrick Model D Stainless Steel Comminuter.
Mikro 4TH, 3TH, 3W, 2TH, 1SH Pulverizers: Schutz O'Neill Mills.
Charlotte #3 Colloid Mill.
Day, Robinson, Tyler Hum-mer, Great Western, Gayco, Raymond Sifters.
Rotex Sifters—40½" x 120" and 40" x 84".

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Sparkler, Sperry, Shriver, Alsop Filters.

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1—Day 15 gal. Pony Mixer, S.S. cans, M.D.
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1—Pfaudler G.L. 300 gal. Jack. Agt. Kettle.
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2—Abbe-Lenart Jack. S.S. Mixers, 110 gals.

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3—Devine single door Vacuum Shelf 20, 18 and 10—40"x43" shelves.
2—Devine 5'x33', 4'x25' Rotary Vacuums.
1—Devine 5'x10' Rotating Vacuum.
1—Hersey 1½'x12' Rotary, 304 S.S.
3—Louisville Steam Tube 6'x50', 6'x35', 38"x25'.
2—Buflovak Atmospheric double drum 42"x120" variable speed drive.
1—Buflovak 5'x12' Atmospheric single drum.
4—Tray Dryers, steam heated, 95 sq. ft. tray area.

FILTERS

5—Sparkler 33-S-28, 150 sq. ft., 304 S.S.
2—Oliver Rotary, Monel 8'x10', 3'x2'.
1—Feinc 5'x3' Rotary Vac, Monel.
2—Feinc 3'x1', Rotary Vac, 316 S.S.
1—Eimco 18"x12", 316 S.S.
2—Sweetland #12-48 & 32 leaves.
1—Sweetland #7, 20 S.S. covered leaves.
1—Niagara #230-32, 230 sq. ft., 304 S.S.
3—Shriver 30" P&F, 36 chambers, iron.
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2—Bird 36"x50", 18"x28" steel, solid bowl, continuous.
2—Bird 24"x38", 18"x28", 316 S.S. solid bowl, continuous.
2—Sharples #C-27, C-20, 316 S.S. Super-D-Hydrators.
1—Sharples PY-14, Super-D-Canter, 304 S.S.
2—Bird 40" suspended, 347 S.S.
1—AT&M 40" suspended, steel.
1—Bird 40" suspended, rubber.
3—Tolhurst 40", 32", 26", suspended.
1—AT&M 40" suspended, steel.
1—Fletcher 30", centerslung, 304 S.S.

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1—Nooter 1000 gal. nickel-clad, jacketed, agitated Reactor.
1—Glascote 500 gal. glass lined, jacketed, agitated Reactor.
1—Pfaudler 500 gal. glass lined, jacketed, agitated Reactor.
2—750 gal. 304 S.S. Kettles with coils and paddle agitators.
1—600 gal., 316 S.S. jacketed, agitated Reactor 200# internal pressure, 75# jacket.
2—500 gal., 347 S.S. jacketed Autoclaves or Reactors, 300# int. pressure, ASME.
3—500 gal., 316 S.S. closed, jacketed tanks.
8—Towers 7'x25'6", 347 S.S., 6'x63', 6'x24', 5'x96', 30"x70', 24"x42', 12"x30', 8"x30'.
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1—10' dia. Hortonsphere, 225 psi.
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2—Foster Wheeler Karbate Heat Exchangers 188 sq. ft.
1—Struthers-Wells 536 sq. ft., 304 S.S.
4—S.S. Heat Exchangers 1200, 947, 58 and 55 sq. ft.
1—Glascote 1000 gal. glass lined Tank.
1—8' dia. x 15' long, 304 S.S. Horizontal Tank, 6000 gals.
1—5'6" dia. x 16' long, 304 S.S. Horizontal Tank, 3000 gals.
2—Unused 7'x9' Vertical rubber lined Tanks, 2500 gals.
3—Steel Storage Tanks 8½x25', 8'x16', 6'x20'.

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4—Bartlett-Snow direct heat Rotary Dryers 8½'x35', 7'x30', 6½'x30'.
1—Raymond 16' dia. single whizzer Mechanical Air Separator.
3—Tyler Hummer Screens 3'x5' single deck Type 38 with Thermionic Units.
6—Bucket Elevators 28' to 55' centers, totally enclosed, 5"x8" to 14"x7" buckets.
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4—Hardinge Mills 4½'x16', 5'x22", 5'x 36", 6'x22", 8'x48".
4—Patterson 6'x8', 5'x6', 3'x4' brick lined Pebble Mills.
1—Devine 5'x10' steel jacketed Ball Mill.
2—National 6"x12" Mills.
3—Gayco Air Separators 16', 6', 18".
3—Mikro Pulverizers, Bantam, #1SH, #2TH.

SCREENS

3—#34 Robinson Triple Deck 30"x104".
6—#21 Rotex single deck 40"x84".
3—#421 Rotex single deck 60"x84".
3—Robinson single deck 40"x84", 304 S.S.
1—Patterson single deck 40"x84", 304 S.S.
2—Tyler Hummer single deck 3'x5', 3'x10'.

MIXERS

1—Baker Perkins 100 gal., 304 S.S. Sigma Blades, jacketed, 25 HP motor.
1—Baker Perkins #JNM-2, 50 gal., 316 S.S., Sigma Blades.
5—Day "Cincinnatus" double arm Sigma blade 200 & 100 gal.
1—4' dia., 304 S.S. Conical Blender, 7½ HP motor.
9—Steel jacketed Powder, 50, 225, 265, 350 cu. ft.
1—Robinson 4000# Steel, Powder.

MISCELLANEOUS

2—Lawrence 5" Hastelloy "C" Centrifugal Pumps.
12—Nash Vacuum Pumps #TS-7, #H-7, #H-6, #H-4, #4, #2, #L-5, #L-4, #AL-574.
3—Stokes 412 and 212 Vacuum Pumps.
20—Durimet, Olivite 316 S.S. Durion Centrifugal Pumps 1" to 3".
10—Centrifugal Pumps 60 to 2000 gpm, motor driven.
8—Stokes DD2, DS3, D3, B2, "R" & "F" Tablet Presses.

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Dopp 150 gal. dbl. st. agitator.
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Hammer: Williams size BX type AK.
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593 CFM 100 PSI 13½-8x8 Ingersoll XRE2
676 CFM 100 PSI 15-9¼x12 Worth
686 CFM 100 PSI 14x13 Chicago T
870 CFM 125 PSI 17-10x12 Chicago Duplex
1600 CFM 40 PSI Fuller C300
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2—Sharples Type 316 Stainless Steel Centrifugals, Model D-2 (New).

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1—Stainless Steel Vertical Storage Tank, 9000 gallons
1—Vertical Stainless Steel Storage Tank, 4000 gallons
1—Stainless Steel Jacketed Kettle, 1200 gallons
1—Van Alst Stainless Steel Jacketed Kettle, 600 gallons
2—L. O. Koven Steel Jacketed Vacuum Reactors, 1000 and 500 gallons, 90 PSI Jacket, 35 PSI Internal
2—L. O. Koven Steel Jacketed Vacuum Reactors with agitator and drives, 750 gallons, 75 PSI Jacket
1—Downington Steel Jacketed Vacuum Kettle, 2000 gal., ASME
5—Pfaudler Glass-lined Vacuum Receivers, 30, 50 and 100 gallons (New)
1—Chicago Bridge & Iron Works, 17,000 gal. Pressure Tank, 80 PSI

DRYERS & KILNS:

2—Stokes Stainless Steel Rotary Vacuum Dryers, 3' x 10'
1—Devine Single Door Vacuum Shelf Dryer, 20 shelves, complete.
1—Allis-Chalmers Rotary Dryer, 7' 6" x 64'
1—Buflovak Double Drum Dryer, 42" x 120", ASME Code
1—Stokes Double Drum Dryer, 5' x 12', complete, ASME
1—Hardinge Rotary Dryer, 5' x 50'
1—Hardinge Rotary Dryer, 7'6" x 55'
1—Bartlett & Snow Rotary Dryer 4' 6" x 36" 6"
1—Link Belt Stainles Steel Roto Lauvre Dryer, Model 207-14
3—Link Belt Steel Roto Louvre Dryers, Models 207-10, 310-16 and 502-20

CENTRIFUGALS:

3—Tolhurst Suspended Type Centrifuges, with 32" Imperforate Baskets, complete.
3—Sharples Stainless Steel Super-Pressurite Centrifuges, Model 16Y
1—DeLaval Type 316 Stainless Steel Multimatic Centrifuge

THE GELB GIRL—APRIL 1957

FILTERS:

1—Niagara Type 316 Stainless Steel Filter, Model 45-30
1—Sweetland #7 Filter with 20 leaves
10—Sweetland #12 Filters with 72 Stainless Steel leaves
1—Republic 15" Flexmaster Stainless Steel Filter, 15 chambers
2—Ertel Stainless Steel Filters, 12", 20 leaves
1—Oliver Rotary Vacuum Filter, Rubber-lined, 3' x 6'
2—Impco Rotary Vacuum Filters, Iron, 5' x 4', complete

MISCELLANEOUS:

1—Stokes Model DDS2 Rotary Tablet Machine, complete
1—Ames 500 HP Steam Generator, 125 PSI
1—Stokes Model R Tablet Machine
6—Stokes Model F Tablet Machines
1—Vulcan Steel Bubble Cap Column, 24" x 30' 20 trays, ASME (NEW)
1—Vulcan Steel Bubble Cap Column 18" x 25'; 18 trays, ASME (NEW)
1—Vulcan Steel Bubble Cap Column, 42" x 30' 20 trays, ASME (NEW)
1—Foster Wheeler Dowtherm Unit, 600,000 BTU
2—Ross Steel Heat Exchangers, 1000 sq. ft. each
1—Abbe Engineering Buhrstone lined Ball Mill, 500 gal., complete
1—Vulcan Stainless Steel Condenser, 200 sq. ft.
2—Stainless Steel Condensers 85 sq. ft. each.

1—Raymond High Side 6-roll Mill, Model 6669, complete with 200 HP motor.
1—Oliver Stainless Steel Rotary Filter, 3' x 6' (New).
1—Baker Perkins Ter Meer, Type 316 Stainless Steel Centrifugal Filter, Model HS-24".
1—AT&M Stainless Steel Suspended Type Centrifuge with 18" Perforated Basket, complete.
1—Bird Continuous Centrifugal Stainless Steel Filter, 24" x 38".

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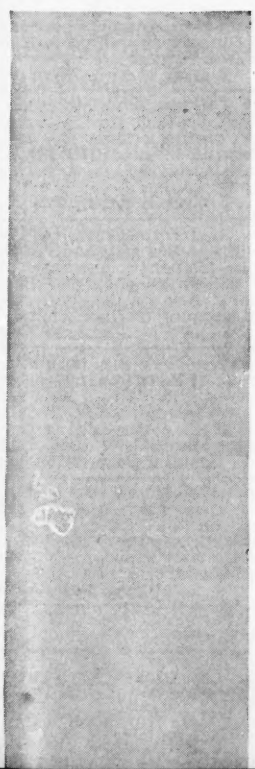

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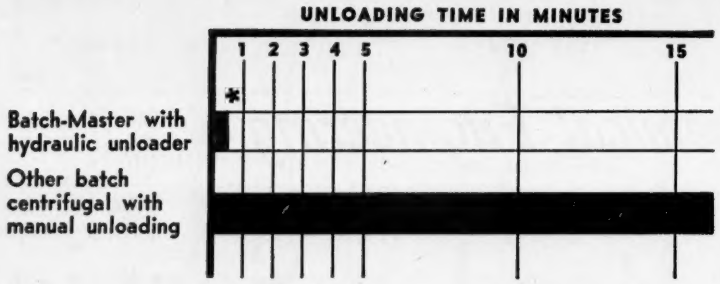
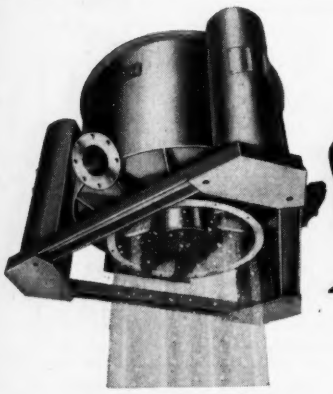


*SAVE 14½ MINUTES (or more) ON EVERY BATCH

Batch-Master Centrifugal can discharge solids in 30 seconds! And under identical conditions of cake hardness, etc., a standard batch centrifugal would take 15 minutes or more!

Save time . . . by pushing just one knob. The plow swings out to the side of the basket . . . plows down the basket side . . . travels back and then swings out of the way. Solids meanwhile discharge automatically through the bottom. This new Batch-Master combines quick discharge with the greater stability of Center-Slung Suspension.



Hydraulic unloader and bottom discharge unload solids automatically in 30 seconds.

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Send your new free 4-page Bulletin TC-14-56 giving full data on Batch-Master Centrifugal.

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TECHNICAL

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Chemicals

Adhesives.....Titled "Adhesives and Coatings from Vinyl Ether Polymers and Copolymers", data sheet P-123 discusses the applications of a series of four related polymers in the compounding of new formulations.
462A Gen. Aniline & Film Corp.

Adhesives.....8-p. reprint of technical paper, "Use of Adhesives With Reinforced Plastics", originally given before SPI. Data on effect of temperature on tensile shear strengths, properties of rigid foams, etc.
462B Rubber & Asbestos Corp.

Alcohol, Polyvinyl.....Tough, flexible films that find many uses on paper products can be produced from solutions of "Elvanol" polyvinyl alcohol. Literature and information available on request.
362c *E. I. du Pont de Nemours.

Aniline.....Offers aniline that exceeds A.C.S. specifications for CP aniline. Uniform quality assured by automatic instrumentation. Will furnish a sample, specifications, price and delivery quotations.
207 *National Aniline Div.

Antifoams.....Information sheet describes properties and applications for this company's antifoam for paint, adhesives, paper, chemical processing. Also provides information on shipping of the chemical.
462C Hodag Chemical Corp.

Antioxidants.....New 8 p. booklet describes use of this company's newest antioxidant in lard, vegetable shortening, salad dressing, vitamins, poultry feed, cattle feed and in packaging materials of many kinds.
462D Catalin Corp. of America

Antioxidants.....Isoascorbic acid and sodium isoascorbic, low-cost antioxidants, are described in a 5 p. technical data sheet. Details on physical and chemical properties and applications. Bulletin 523.
462E Chas. Pfizer & Co.

*From advertisement, this issue

LITERATURE

C. J. ROHRBACH

Butyl Oleate.....Witco butyl oleate has been found to be the best and most economical plasticizer for use in Neoprene Type WRT. Includes complete information on properties in Technical Bulletin E-9.
463A Witco Chem. Co.

Carbon, Activated..... New bulletin tells how to treat liquid waste with Adsorbit activated carbon to remove all types of organic impurities, and many organic materials. Full details in Bulletin J-30.
463B Barnebey-Cheney Co.

Catalysts.....Girdler G-35 catalysts retain outstanding physical properties after repeated regenerations and use. Permit outstanding operational flexibility, continuous economical operation. Bul. GC304.
117 *Girdler Co.

Chemicals.....New edition of Dow's general product catalog contains more than 375 basic industrial, agricultural and pharmaceutical chemicals. Includes information on principal product groups.
463C Dow Chemical Co.

Chemicals, Organic.....Company's index for 1957 lists several new products for the first time. Include trimethylopropane for making alkyd-based baking enamels, vinyl propionate, Cellulube 300, 550 and 1000.
463D Celanese Corp. of America

Curing Agents.....8 p. technical information bulletin No. F-8665A covers amine curing agents for liquid epoxy resins and for epoxy coatings. Information on how to select and apply.
463E Carbide & Carbon Chem. Co.

Defoamers, Silicone.....Dow Corning "Antifoam B" disperses immediately in aqueous solutions. No stirring or agitation required. Ready to use & ideal for continuous processing. Particulars free sample.
83 *Dow Corning Corp.

*From advertisement, this issue

Contents of this issue . . .

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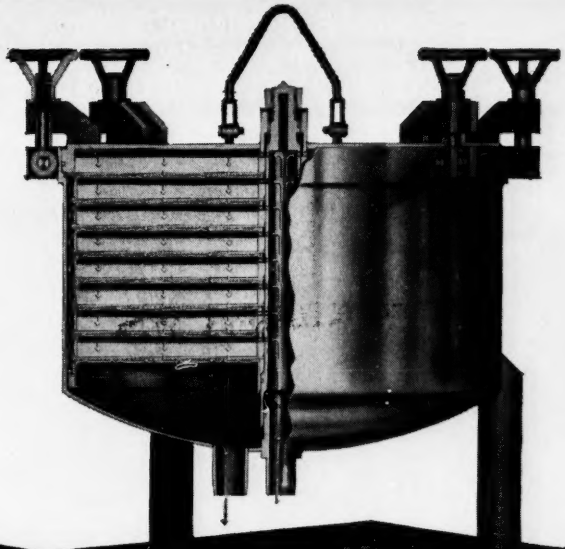
Pump, blowers, compressors 496
Services and Processes 499



SIMPLEST, QUICKEST
horizontal plate filter
FOR RECOVERING CAKE

Quick to disassemble: Slip hoist hook through lift-ring . . . remove cover and plate bundle together. Take off compression nut. Then remove cover from plate bundle by the same lift-ring. Plates slide up and off central manifold. No tie rods save downtime. Reassembly just as easy. 18" and 33" plate diameters, ranging in filtration area from 7.4 to 250 sq. ft. Built to code requirements and can be code-stamped for 75 psig standard. Higher pressures available. With steam jacket if desired.

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A DIVISION OF
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Niagara Filters Europe: Kwakelpad 28, Alkmaar, Holland.

☐ Send Bulletin with complete data on the new Niagara "Batch-Miser" Horizontal Plate Filter for handling _____

☐ Send details on renting a pilot model.

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COMPANY _____

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External Adjustment & Calibration
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PRESSURE & VACUUM CONTROLS **H5** **H12**

TYPE H5

TYPE H12

UNITED ELECTRIC designed these controls for industrial applications where outside adjustment and calibration are important factors. Types H5 and H12 accurately and sensitively control liquid level alarms and air gas pressures. The type H5 (minimum 2 psi differential) controls up to a maximum of 500 psi, and the type H12 (minimum 3" wc differential) up to 180 psi. Uncalibrated, internally adjusted versions of these controls are available as type J7 and type J6 respectively.

Switch Differential	H5 — Uniform on-off differential, fixed from 2 psi to 30 psi. H12 — Uniform on-off differential, fixed from 3" wc to 2 psi.
Switch Ratings	15 amps. at 115 or 230 volts AC, also 20 amps. or DC switches on specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size & Weight	H5 — 5⅛" x 4⅞" x 1½" . . . weighs approx. 1 lb. H12 — ¾" x 2¾" x 5" weighs approx. 1 lb. 6 oz.
Electrical Connection	Conduit opening in enclosure — ⅞" O.D. Internally-located terminal block.
Enclosure	Die-cast aluminum case with black wrinkle finish.
Mounting	H5 — Directly, by ¼" female NPT on bellows housing; or surface mounted by mounting ears on each end of case. H12 — Directly, by ¼" female NPT on bellows housing.
Bellows	H5 — Spring loaded, seamless brass, stainless steel or monel. H12 — Spring loaded, seamless brass bellows.
Pressure Connections	¼" female NPT.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. UE will gladly modify or custom-build a unit to meet your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 5-5 for complete H5 data and Bulletin No. 5-2 for complete H12 data.

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COMPANY
85 SCHOOL STREET, WATERTOWN, MASS.

LITERATURE . . .

Elastomers.....Neoprene and Hypalon elastomers are used in improving products and cutting maintenance and replacement costs. Full details available in publication. "The Du Pont Elastomers."
91 *E I du Pont de Nemours.

Ethylene Amines.....8 p. bulletin No. F-8163A tabulates physical properties and specifications of ethylene amines. Describes their application in agriculture, chelating, polyamides; textile.
464A Carbide & Carbon Chem. Co.

Flavors..... Called "The Changing World of Food", new 36 p. booklet surveys the newer aspects of the food industry with particular emphasis on the part played by flavors and seasonings in the total picture.
464B Dodge & Olcott, Inc.

Flavors..... "Pharmaceutical Flavor Guide" catalogues flavors developed for and proven adaptable to the flavoring requirements of modern pharmacy. Lists more than 200 different flavoring suggestions.
464C Fritzsche Bros.

Formaldehyde.....High purity 50% and 37% formaldehyde available from du Pont. Methylene ($-CH_2-$) group functions as "chemical button" to link similar or dissimilar molecules. Details.
362e *E. I. du Pont de Nemours.

Hydrogen Peroxide....."Albone" hydrogen peroxide and "Albone" bleaching solutions are applied usually by spraying, although brushing, wiping or dipping, are sometimes used. Request product literature.
362d *E. I. du Pont de Nemours.

Lubricants.....Bulletin V-220, Rev. 1, called "Lubricants for Rockwell-Nordstrom Valves" provides 12 p. of detailed lubricant selection data including information on about 80 new lubricants.
464D Rockwell Mfg. Co.

Mastics.....Role of gilsonite-asphaltic mastics in the corrosion protection of chemical plant, pulp mill, and other industrial installation is described in a new 4 p. folder. Covers four basic types of gilsonite mastic.
464E Emjay Maintenance Engnrs.

Metal Powders.....2 p. engineering data sheet 53 discusses use of metallizing powder, a material high in chromium and nickel and containing chromium borides, for crankshaft bearing surfaces.
464F Wall Colmonoy Corp.

Methylene Chloride.....Combination of properties, including high solvent power for many organic compounds —both those of non-polar and polar nature. Has many diversified uses. Literature.
362a *E. I. du Pont de Nemours.

Molybden Disulfide.....1 p. bulletin describes the uses of molybdenum disulfide as a filler in nylon, phenolic laminates, Teflon and other plastics, natural and synthetic rubber and asbestos.
464G Climax Molybdenum Co.

Nitrate of Soda.....Your choice of three crystal sizes-coarse (1-C), medium (2-B) and fine (3-A). Select the one that suits your operation and save on processing and handling. Literature.
153 *Allied Chem. & Dye Corp.

* From advertisement, this issue

Nitroparaffins . . . . . As solvents, the NP's present an unusual combination of properties. Request Technical Data Sheet for specifications, properties, uses, solubility tables, etc. plus product samples.
181 *Commercial Solvents Corp.

Ozone.....Welsbach ozone is versatile in its applications and low in cost. Is finding more and more applications in industry. Used, for example, as an oxidant in the manufacture of cortisone. Booklet.
R489a *Welsbach Corp.

Pharmaceuticals ..... Specially prepared form of hydrogenated Squalene and its use as a vehicle for topical pharmaceuticals and cosmetics is described in a new 4 p. leaflet. Properties and benefits.
465A Robeco Chemicals, Inc.

Pigments.....List of this company's organic and inorganic pastes for vinyls to aid in the selection of the right pigment or pigment types. Includes such data as pigment type, % pigment, % DOP.
465B Harwick Standard Chem. Co.

Piperazine..... Properties, reactions and uses, particularly in the pharmaceutical industry, of piperazine are described in a new booklet. Toxicological and handling information is included.
465C Dow Chemical Co.

Plasticizers.....Bulletin 80 describes methods of preparation and individual properties of several different epoxy fatty acid ester plasticizers. Plasticizers can be prepared from unsaturated fatty acid esters.
465D Becco Chem. Div.

Plasticizers.....Bulletin gives test recipe used & physical test data for Witco #20, a plasticizer for natural rubber tread stocks. Mooney Scorch time 25% longer than Pine Tar recipe. Bulletin R-12.
465E Witco Chem. Co.

Polyphenyl, Chlorinated.....Aroclor 1248 is a highly stable chlorinated polyphenyl; does not support combustion up to its boiling range 652° to 725°F.; is non-corrosive. Request technical information.
399a *Monsanto Chem. Co.

Potash, Caustic.....Offers: solid, flake, granular, broken, crushed, powder, walnut, at 90% strength; solid and flake, at 85% strength; liquid, low-chloride at 45% strength. Details in bulletin.
50-1b *Hooker Electrochem. Co.

Rare Earth Products.....Collection of technical data sheets in 12 p. brochure covers line of rare earth products including samarium oxide, europium oxide, gadolinium oxide, ytterbium oxide, yttrium oxide.
465F Michigan Chemical Corp.

Reagents.....Catalog 56 covers 1,300 reagents and other high-purity chemicals made by this company. Includes new additions to the line such as EDTA and the disodium salt and metal indicators.
465G J. T. Baker Chemical Co.

Reagents . . . . . Complexing agents available in laboratory quantity described in 4 p. data sheet. Include (tetra) sodium ethylenediamine tetraacetate, (tetra) potassium athylene diamine tetraacetate.
465H Fisher Scientific Co.

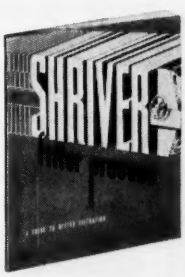
* From advertisement, this issue

More Versatile
Dependable · Economical

SHRIVER FILTER PRESSES

for

- ✓ Recovery of Solids
- ✓ Perfect Clarification
- ✓ Washing and Extraction
- ✓ Drying Cake
- ✓ Redissolving and Melting
- ✓ Thickening Slurry



Because of their ability to perform any of the above functions over the widest range of pressure and temperature, and withstand practically all conditions of corrosion and erosion, Shriver Filter Presses are the most extensively used of all batch type pressure filters. They cost less and require less floor space per unit of filtering capacity.

Write for this Shriver guide to better filtration.

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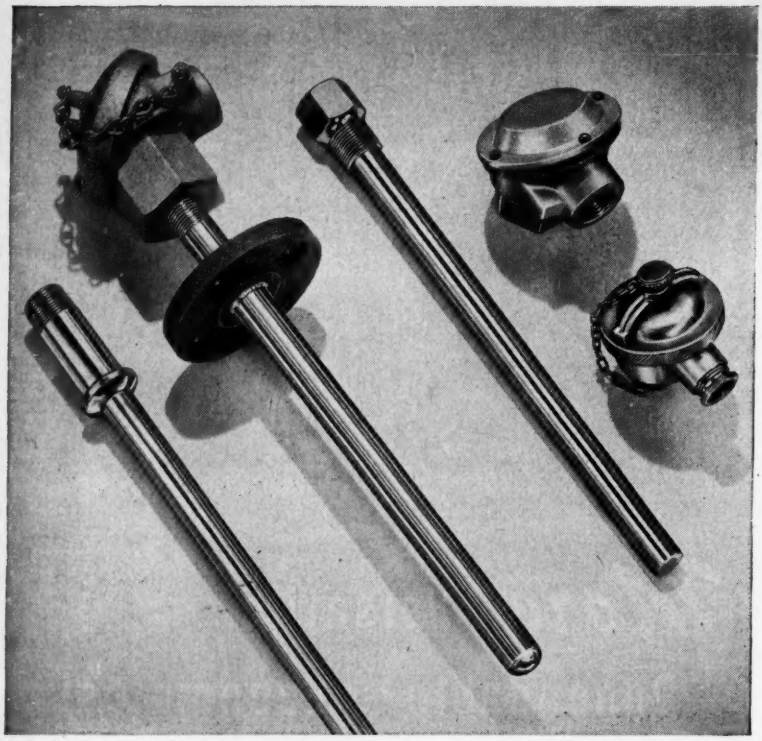


For *Complete* Dependability

Choose From T-E's *Complete* Line of

THERMOCOUPLE ASSEMBLIES

At Thermo Electric you'll find everything for your temperature measuring needs—sensing elements, instruments and accessories. T-E's thermocouples are a good example. There's one for *every* application, *every* operating condition. And each T-E thermocouple is manufactured under close control to exacting standards. They're available in Iron-Constantan, Copper-Constantan, Chromel-Alumel and Platinum-Rhodium-Platinum.

Heavy Duty Thermocouples—wire and tubular—provide the rugged construction needed for severe conditions, while retaining sensitive performance.

Protection Tubes (Thermo-Wells)—bar stock or built-up, straight or tapered, with threaded, flanged or ground-joint mountings—are available in all commercial materials for all applications.

Miniature Thermocouples are made in a wide variety of types and sizes for any installation requiring a small-size yet sensitive assembly.

Accessories include a complete selection of connection heads, fittings, terminals, quick-coupling connectors and extension wires.

Thermo Electric Co., Inc.

SADDLE BROOK, NEW JERSEY

In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

LITERATURE . . .

Resins, Epoxy.....For engineers and chemists responsible for design of epoxy resin encapsulation processes, bulletin TB 18 describes physical and electrical properties of a series of filled resins.
466A Smooth-On Mfg. Co.

Resins, Ion Exchange.....4 p. folder gives price information on analytical-grade anion exchange resins, cation exchange resins, and monobed resins plus a section on selection of specific resins.
466B Bio-Rad Laboratories.

Resins, Tetrafluoroethylene.....Teflon tetrafluoroethylene resins used extensively in process industries. Offer chemical inertness, high heat resistance, low-temperature toughness. Properties & applications.
19 *E. I. du Pont de Nemours.

Rust Removers.....Leaflet describes Ferox, solution to remove rust chemically by destroying oxidase causing rust in same manner comparatively as growth of bacteria is arrested germicides.
466C Service Industries.

Sieves, Molecular.....Molecular sieves dry your gases—air, hydrogen, chemical streams—more thoroughly than any other commercial adsorbent. Remove last traces of moisture. Data sheets.
419 *Linde Air Products Co.

Silicones.....New 8 p. illustrated catalog CDS-97 discusses more than 115 different applications for silicones. Covers use in rubber products, cosmetics and polishes, electrical insulation, water repellants.
466D General Electric Co.

Soda, Caustic.....“Caustic Soda Buyer's Guide” contains helpful facts on economics of 50% and 73% solutions; other forms of caustic soda; capacities of tank cars and other containers; etc.
50-1a *Hooker Electrochem. Co.

Sodium.....For production of countless number of useful alcohols from plentiful fats and oils, improved general method has been developed for reducing esters with metallic sodium. Literature.
362b *E. I. du Pont de Nemours.

Sodium Hydride Oil Dispersion..... Detailed reference contains information on composition, properties, solubility, applications, typical reductions, handling, safety and storage. Request Bulletin 508-A.
466E Metal Hydrides.

Sodium m-Silicate.....Valuable data on Drymet anhydrous—the most highly concentrated form of sodium m-silicate. Drymet Folder contains technical data and suggested formulations. Request your copy.
B518 *Cowles Chem. Co.

* From advertisement, this issue

Any bulletin or catalog . . . yours for the asking

You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

Solvents.....Leaflet describes quick-acting solvent for gummed tape and glue said to eliminate foul odors from all sealing operations. Covers where and how product can be used and benefits derived.
467A Service Industries.

Sorbic Acid.....8 p. bulletin F-8526A contains tables and graphs showing physical properties, solubility in various solvents. Directions for addition of sorbic acid to foods like cheese products, pickles.
467B Carbide & Carbon Chem. Co.

Surface Active Agents ..... Called "Tergitol Surface Active Agents", 40 p. booklet provides selection data in tabular form for a complete line of products. Individual sections cover industrial applications.
467C Carbide & Carbon Chem. Co.

Surface Active Agents.....Technical data sheet No. 3A, 2 p., describes company's Alkaterge-T, a non-volatile, weakly cationic amine-type compound. Specifications, physical properties, uses, toxicity.
467D Commercial Solvents Corp.

Surfactants.....40 p. booklet of charts shows properties of Sandopan DTC which make it useful in cotton, wool, rayon and synthetic processing. Includes charts on surface tension in distilled water.
467E Sandoz Chemical Works.

Terpene Oxides.....Terpene oxides—dipentene monoxide and a-pinene oxide—have potential uses as intermediates in manufacture of protective coatings, insecticides, adhesives, etc. Buls. 81 and 82.
205 *Becco Chem. Div.

Trichlorethylene ..... 40 p. booklet covers physical and chemical properties, shipping containers, safe handling procedures, etc. See Bulletin 44. Data Sheet 787 gives information on all grades.
50-1c *Hooker Electrochem. Co.

Construction Materials

Alumina.....Of many electrochemically refined materials produced by company, Alundum fused alpha alumina is one of the most useful. Request "Norton Refractory Grain —Electrochemically Refined."
101 *Norton Co.

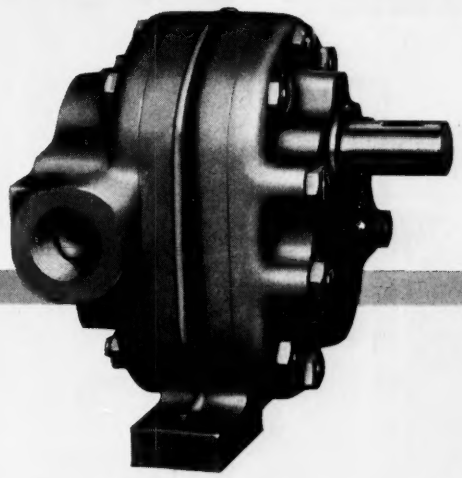
Castings, Aluminum.....If you require parts with demanding metallurgical properties, close tolerances and intricacy, Bean's foundry techniques may provide a solution. Request technical booklet.
344 *Morris Bean & Co.

Castings, Stainless Steel.....Second edition of 28-page booklet gives detailed information on corrosion and heat resisting stainless steel castings. Physical properties and chemical compositions given.
384 Allegheny Ludlum Steel Corp.

Coater, Spray Thermoplastic.....Application of thermoplastic resin powders to metal parts is discussed in new catalog sheet. Dual-purpose unit provides for both spray and fluidized coating techniques.
467F American Agile Corp.

*From advertisement, this issue

Handling Hazardous Liquids?



LET ROPER DEVELOP A SAFER SYSTEM FOR YOU

The advantages and safeguards of pumping hazardous liquids from a remote power source are yours with Roper Hydraulic Pump-Motors. In such instances, these rotary gear units act as the remote prime mover pumps in hydraulic circuits, and as low speed, high-torque motors to drive product pumps. Flexibility, reversibility, and dependability earmark Roper units as highly desirable where safety is paramount. Send for data on single and double shaft models — sizes to develop up to 11.5 H.P.

Advantages of Roper Hydraulic Pump-Motors

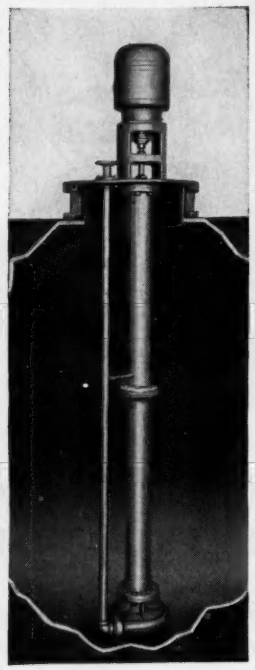
1. Can be used with existing hydraulic equipment to replace manual operations, or to replace gear trains or mechanical controls.
2. Especially suited for explosion-proof applications.
3. Can be stalled without damage to themselves and other equipment.
4. Provide positive control over wide range of operating conditions.
5. Compact and space saving.
6. Provide increased flexibility of installation.
7. Cut maintenance costs.

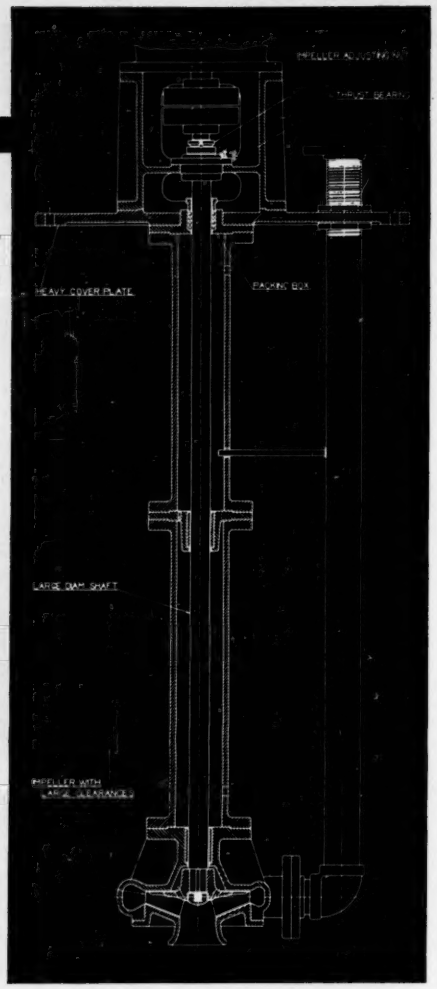
ROPER Rotary Pumps

Ask for Bulletin 22

GEO. D. ROPER CORPORATION
454 Blackhawk Park Avenue
Rockford, Illinois

(Right) Structural details of Lawrence Vertical Chemical Pump.
(Below) Vertical Chemical Pump mounted inside of tank.



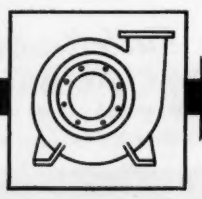


VERTICAL CHEMICAL PUMPS

Difficult chemical pumping problems—handling hot concentrated acids, corrosive alkalies, molten salts, molten sulphur, volatile semi-fluids, etc.—have been a LAWRENCE specialty for over 80 years.

To meet the demands of this rigorous service, LAWRENCE Vertical Chemical Pumps are made of metals or alloys carefully chosen to give the best protection against the corrosive and abrasive action of the liquid pumped, as well as structural strength and long wear. Other design features (depending on the circumstances) include liquid seals for high vacuum, the elimination of packing, mounting bearings above the level of the liquid pumped to prevent contact, and many more refinements that contribute vitally to efficient, trouble-free operation.

If you have a particularly difficult chemical pumping problem, write us the pertinent details.



LAWRENCE PUMPS INC.
371 MARKET STREET, LAWRENCE, MASS.

LITERATURE . . .

Coatings, Neoprene.....Use Atlas neoprene coatings to solve these problems: maintenance of ceilings, walls, trenches and structural members, or the protection of vessels, tanks, etc. Bul. 7-N.
351 *Atlas Mineral Products.

Coatings, Protective.....Bulletin describes how good structural design aids coatings in protecting steel surfaces. Tells how to weld, rivet & use structural materials to avoid creation of corrosion problem areas.
303 *Amercoat Corp.

Coatings, Protective.....4 p. leaflet describes coating designed to control the transmission rate of water vapor through any type of building material. How to apply to the interior or exterior surface.
468A Ellis & Watts Inc.

Coatings, Protective.....If you have a stubborn corrosion problem Tarset may be able to extend the life span of your equipment and eliminate costly down time needed for repairs. Details in booklet.
97 *Pittsburgh Coke & Chem. Co.

Concrete, Prestressed.....Design and construction data for prestressed concrete tanks are presented in 4-page bulletin T-15. Also includes condensed data for other uses of prestressed concrete.
468B Preload Co.

Fibers, Polyester.....New type industrial fire hose jacketed with 100% Dacron offers these advantages: lightweight, resistant to many chemicals, weather- and mildew-resistant. Booklet and details.
82 *E. I. du Pont de Nemours.

Grating, Non-Skid.....Catalog R-655 discusses Relgrit non-skid grating for walkways, stairways and platforms. Catalog includes technical information, available sizes, safe load tables, etc.
468C Reliance Steel Products Co.

Insulation, Pipe.....Catalog features easy way to select economic thickness of pipe insulation accurately ...efficiently. Introduces simplified method based on a special "J" factor. Unibestos Catalog.
429 *Union Asbestos & Rubber Co.

Insulation, Underground ..... New quarterly company magazine "Pipe Insulation News" will carry stories and articles dealing with the problems of insulating underground hot pipes with Gilsulate.
468D American Gilsonite Co.

Laminates, Metal.....Detailed engineering information on properties, applications, types, sizes, etc. of Bridgeport metal laminates is presented in 8-page technical bulletin now available.
468E Bridgeport Brass Co.

Metals.....Kennametal is available in many standard forms, in addition to special shapes and parts, such as: rectangular blanks, discs, rods, tubes, flats, balls, rings. See Bulletins B-111A and B-222.
500 *Kennametal, Inc.

Metals, Expanded ..... Bulletin describes new Micromesh expanded metal with openings ranging from 1/16 up to 2½ in. Using basic diamond pattern, material can be produced from wide variety of metals.
468F Designers Metal Corp.

* From advertisement, this issue

Metals, Talide.....Tungsten carbide of superior quality, is harder, stronger, and more resistant to abrasion than any other metal. Superior where wear, heat and strain are destructive. Catalog 56-G.
134 *Metal Carbide Corp.

Refractories.....Carborundum has pioneered scores of super refractories with a wide variety of properties to meet your most demanding requirements. For details, request new "Refractories" magazine.
315 *Carborundum Co.

Rubber & Plastic Materials.....Piping pumps, valves and tanks have a wide range of temperatures, pressure, impact resistance. For details about Ace rubber and plastic Materials, request Data CE-50.
321a *American Hard Rubber Co.

Sheet, Stainless.....Steel industry estimates that 50% of stainless sheet applications could employ type 430 as an economical and practical material. See, "Care & Use of 430 Micro-Rold Stainless Steel."
396 *Washington Steel Corp

Steels, Clad.....One side corrosion resistant nickel or high alloy; the other rugged, economical carbon or alloy steel. Permanent bond produced by heat and pressure on rolling mills. "Clad Steel Equipment."
217a *Lukens Steel Co.

Steels, Stainless.....Company offers informative 44 p. booklet, "Making the most of Stainless Steels in the Chemical Processing Industries." Dozens of Crucible stainless grades are available to you.
389 *Crucible Steel Co. of America.

Tapes, Insulating.....Four-page booklet describes four types of polytetrafluoroethylene electrical insulating films and tapes. Chart lists properties and methods for applying each type.
469A Minnesota Mining & Mfg. Co.

Steels, Stainless ..... Comprehensive 40-page manual gives all the latest information on approved techniques for fabricating stainless steel. Included in manual 590a are cold forming and other methods.
469B Republic Steel Corp.

Titanium....Shows resistance to chloride solutions and retains useful strength up to 800-1000F. Other advantages and data on application and fabrication of titanium alloys in Rem-Cru Review.
226 *Rem-Cru Titanium.

Tungsten Carbide.....Characteristics of Kennametal Grade K501 are discussed in new bulletin, Form L 501. This tungsten carbide with platinum binder is for severe corrosive conditions. Gives properties, uses.
469C Kennametal, Inc.

Electrical & Mechanical

Cable, Electric.....New 28-page booklet "How to Insulate a Cable" explains four methods for applying insulation to electrical conductors. Helps user to choose the right cable for his needs.
469D Okonite Co.

* From advertisement, this issue

• here's why-

Peabody Cylindrical Air Heating Furnaces, the standard of dependable performance throughout the world, are used by industry to solve difficult processing problems. If you require hot air and combustion gases at pressures from atmospheric to 10 atmospheres for gas turbines, spray dryers, kiln dryers, chemical, food or petroleum processes, catalyst regenerators, flight shape or aircraft component testing facilities, Peabody can deliver!

Compact and flexible in design, simple in operation, Peabody units are custom-engineered to individual job specifications. Peabody Air Heaters require little space, attention or maintenance. Write for Bulletin 600A.

PEABODY ENGINEERING CORPORATION
232 MADISON AVENUE, NEW YORK 16, N. Y.
OFFICES IN PRINCIPAL CITIES
PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

7-055

Tomorrow's
MODERN DESIGN
for
Today's Demands!

MORRIS PUMPS

keep the aluminum industry rolling toward

GREATER CAPACITY

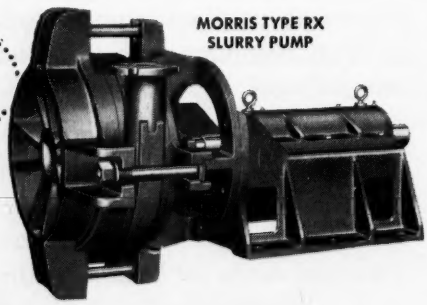
In pace with the far-sighted aluminum industry, other leading manufacturers the country over shrewdly specify Morris for heavy duty pumping.

The Morris Type RX Slurry Pump is rugged, dependable, and trouble free. It's specifically designed for heavy pumping; gives peak performance under all conditions, including heavy, coarse or fine slurries, dispersions and sludges.

The Morris pump operates with minimum attention . . . lowers maintenance costs . . . can be quickly dismantled for inspection . . . avoids lengthy lay-up time. For heavy duty pumping . . . specify Morris.

WRITE TO MORRIS TODAY for recommendations of the pump best suited to your size, capacity, specifications. Ask for Bulletin 185.

MORRIS
CENTRIFUGAL
PUMPS



MORRIS TYPE RX
SLURRY PUMP

MORRIS MACHINE WORKS
Baldwinsville, N. Y.
Sales Offices in Principal Cities

LITERATURE . . .

Clutches, Air-Grip.....Dodge offers new bulletin on Air-Grip Clutches. This bulletin presents technical data, sizes and selection tables. Complete details in Bulletin A634. Request your copy.
323a *Dodge Mfg. Corp.

Connectors, Pipe, Flexible.....Chemlon connectors are fabricated from the most chemically resistant material available, DuPont Teflon. Most destructive acids have no deteriorating affect. Information.
345 *Crane Packing Co.

Doors, Automatic.....Two new catalogues describe "Prest-O-Matic" electric industrial door units, fire door operators and cold storage door assemblies. Request your copies.
470A Clark Door Co.

Drives, Fluid, Dry.....New development, Flexidyne, the dry fluid drive, starts loads smoothly; protects against shocks and overloads; saves power; gives 100% efficiency at full load. Bul. A-640.
322 *Dodge Mfg. Corp.

Drives, Silent Chain.....Book gives details and advantages . . . complete technical data on Link-Belt silent chain drives. Humidity, heat, cold do not lower chain's better than 98% efficiency. Book 2425.
99 Link-Belt Co.

Fastenings.....150,000,000 standard fastenings in brass, bronze, stainless, aluminum, copper, nickel and monel. Laboratory tests prove greater strength of Harper stainless machine bolts. Form 126.
334 *H. M. Harper Co.

Gaskets..... Booklet "Color-Plast Gasket & Shim Stock" and color-coded size selector describes washers, gaskets, shims, seals and spacers. Each of 12 gages from 0.001 to 0.030 is identified by its own color.
470B General Gasket.

Gaskets.....Chemiseal teflon jacketed gaskets for standard flanges and glass-lined steel connections and for corning conical flanges. Company makes full details available in Catalog No. AD-154.
353a *U. S. Gasket Co.

Lights, Emergency.....Catalog 11-1957 gives complete information on Light Warden automatic emergency lighting units. Manufacturer suggests customer use of engineering service without obligation.
470C Electric Cord Co.

Lights, Flood.....New illustrated catalog 156 covers entire line of cast aluminum floodlights in 48 pages. Includes complete lighting performance tables for new high-efficiency projector lamps.
470D Stonco Electric Products Co.

Lubrication Systems.....Lubricates any bearing on any machine with one of three types of fittings: mist fittings, spray fittings, condensing fittings. Full details in Oil-Mist catalog.
59 *Stewart-Warner.

Motors.....Fairbanks-Morse design and manufacture set the standard of performance for motors that fulfill NEMA B, C and D requirements. Bulletin 1150 includes details on F-M Copperspun rotor.
386 *Fairbanks, Morse & Co.

* From advertisement, this issue

BE SURE OF A PERFECT CONICAL SHAPE SPRAY ALL THE TIME WITH *Monarch*

For a perfect spray, many plants prefer Monarch nozzles.

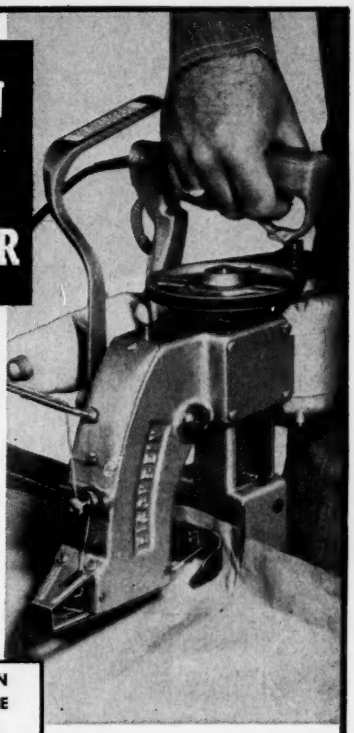
These advanced design nozzles reduce clogging and guarantee dependable applications to . . .

- ACID CHAMBERS
- AIR WASHING
- CHEMICAL PROCESSING
- COOLING PONDS
- DESUPERHEATING
- GAS SCRUBBING
- HUMIDIFYING
- SPRAY DRYING

Send for catalogs 6A and 6C

Monarch
MFG. WORKS, INC.
2517 E. ONTARIO ST.
PHILADELPHIA 34, PA.

FISCHBEIN *Portable* BAG CLOSER



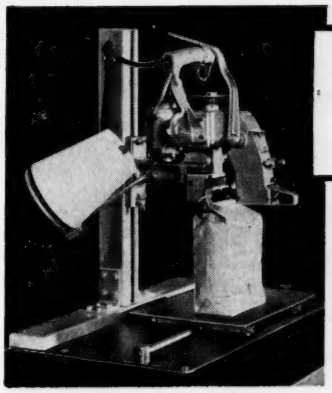
HANDLES ALL TYPES OF BAGS!

- Total weight. 10½ lbs.
- Requires no installation . . . plug into any outlet
- Simple to operate and maintain
- Lowest priced bag closer on market

FULLY GUARANTEED!

OPTIONAL SUSPENSION UNIT ADAPTS MACHINE TO STATIONARY USE

NEW! FOR CLOSING SMALL BAGS!



FISCHBEIN TABLE MODEL CARRIAGE CONVEYOR
(Model FS)

One simple knob locks any Fischbein Portable Bag Closer into proper sewing position. Carriage slides freely and returns automatically to starting position, ready for next bag.

UNIQUE VERSATILITY! Any Fischbein Bag Closer can be used 3 different ways!

1. Completely portable
2. Suspended with counterbalance
3. On carriage conveyor for closing small bags

FOR DETAILS, MAIL THIS COUPON TODAY!

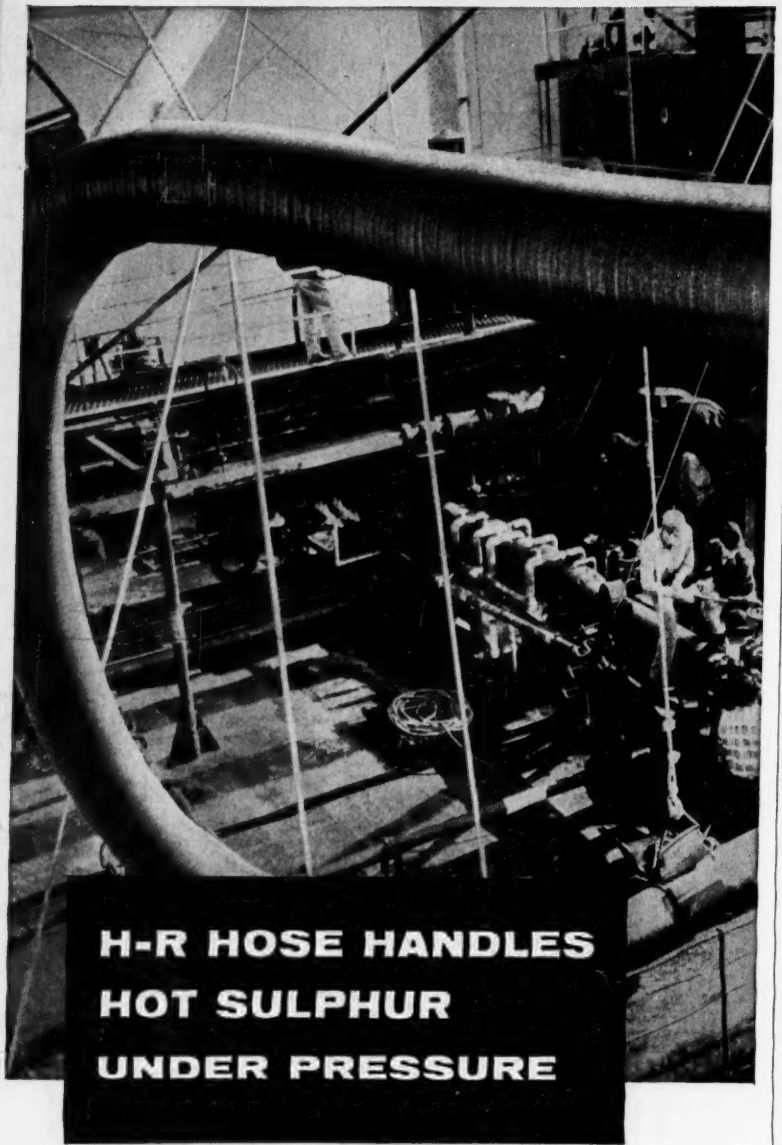
DAVE FISCHBEIN CO., DEPT. 3C
2730 30th Ave. S., Minneapolis 6, Minn., U.S.A.

Name_____

Firm Name_____

Address_____

City_____ Zone____ State_____



To speed molten sulphur shipments to its customers, Freeport Sulphur Company needed a hose that would withstand high temperature, high pressure and chemical action.

To meet these requirements, Hewitt-Robins developed a flexible, sulphur-resistant hose that withstands working pressures of 200 psi; temperatures up to 275° F, with a flow rate of 800 tons per hour. The economy and efficiency realized through the use of this Molten Sulphur Hose has led to its adoption by other handlers of this product. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

HR HEWITT-ROBINS

CONVEYOR BELTING AND IDLERS...POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE...VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

LITERATURE . . .

Motors.....Bulletins describe open type or totally enclosed motors featuring: more power in less space, corrosion resistant frames, needed protection, longer bearing life. See Bulletins MU-202 and MU-203.
90 *Wagner Electric Co.

Motors, Electric.....New 12-page Application Guide 102 makes selection of electric motors easy for all popular applications. Guide tells type needed, dimensions and other pertinent data.
472A Century Electric Co.

Motors, Explosion-Proof.....New improvements in Louis Allis explosion-proof motors meet latest demands of abusive chemical service. They are also tough-shelled and corrosion-resistant. Bulletin 800.
410 *Louis Allis Co.

Motors, Flat Type.....Illustrated bulletin 3461 describes both Type DIE totally enclosed, non-ventilated and Type DIF totally enclosed fan-cooled flat-type motors. Lists ratings, compares sizes.
472B Diehl Mfg. Co.

Motors, Heat Resistant.....Bulletin M100 describes line of motors that can operate with shafts exposed to temperatures up to 2,100 F. Table lists standard ratings and frame sizes.
472C Kaybee Engineering Co.

Motors, Pumps, Hydraulic.....Flexibility, reversibility, and dependability earmark Roper units as highly desirable where safety is paramount. Data on single and double shaft models in Bulletin 22.
467 *Geo. D. Roper Corp.

Packings, Mechanical.....New 4 p. folder lists the all-purpose packings of asbestos, duck fabric, teflon, etc. that company has developed for use in a wide range of applications. Copies on request.
472D Flexrock Co.

Packings, Plastic.....“Versi-Pak” is primarily designed for solvent and oil service up to 350°F. and 600 psi. Also does a superior job on water solutions, weak acids and caustics. For details see booklet.
359 *Raybestos-Manhattan.

Packings, Ring.....Furnishes complete descriptions of the Chempro lines of teflon ring packings, teflon impregnated asbestos packings, V-type packings and the patented teflon seal cage. Bulletin CP552.
L486 *Chemical & Power Products.

Pulleys, Motor.....Reeves Vari-Speed motor pulleys get greater productivity; run at most economical production speed; handle production or process variables with the same machine. Request bulletin.
342 *Reeves Pulley Co.

Saddles, Intalox.....Reference offers technical data and specifications on Intalox Saddles. Including comparative charts showing relative pressure drops, flooding limits, etc. Bulletin S29-R.
138 *U. S. Stoneware Co.

Saw, Masonry.....2 hp. masonry saw with sta-level cutting head and hi-lo control wheel plus 30 other outstanding features is described in Brochure No. 2017. Available on request.
472E Clipper Mfg. Co.

* From advertisement, this issue

Seals, Mechanical.....Valuable reference for maintenance engineers and original equipment designers. Illustrates and describes types of Dura seals engineered to meet your specifications. Catalog No. 480.
BR507 *Durametallic Corp.

Seals, Mechanical, Rotary....Company announces the availibility of an 8 p. reference which shows how you get maintenance-free sealing that slashes fluid mixing cost to a new low. Bulletin B-111.
283g *Mixing Equipment Co.

Separators, Magnetic.....Type K magnetic separators have the power and efficiency to concentrate and purify materials previously considered unresponsive to magnetic treatment. See Bulletin 701-BB.
394 *Sterns Magnetic Products.

Sprockets....Taper-Lock double strand sprockets are available—ready for the shaft without re-machining. There is no flange, no collar, no protruding part. Flush design means safety. Bulletin A-644.
323b *Dodge Mfg. Corp.

Standards, Lighting.....New edition of the RLM Standard Specifications for Industrial Lighting Units contains important specification revisions on both incandescent and fluorescent industrial units.
473A RLM Standards Institute.

Transmitters, Potentiometer.....Unit continuously standardized automatically; easy continuous adjustment of range span and zero suppression; both electronic and pneumatic units plug in, etc. Bul. 98262.
54-4 *Taylor Instrument Cos.

Turbines.....Both regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. "L" type wheel is for use where water rate is essential. Bul. 135.
133 *Coppus Engineering Corp.

Turbines.....Simplicity and adaptability of Elliott YR Turbine give it advantages that put it well ahead for pump, fan, compressor and other machine applications. Details in Bulletin H-22A.
113 *Elliott Co.

Handling & Packaging

Autoclaves.....Magne Dash Autoclave features: no stuffing box, no external moving parts, positive agitation in both directions, variable agitator speed, electrical heating. Details in Bulletin 1051-B.
39 *Autoclave Engineers.

* From advertisement, this issue

Any bulletin or catalog . . . yours for the asking

You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

CORROSION

TYPE	HOW TO IDENTIFY
GALVANIC	Localized deep grooves or pits, often at contact between dissimilar metals.
UNIFORM	Uniform attack—may be on only one part.
INTERGRANULAR	Attack at grain boundaries.
PITTING	Rapid, deep pitting at several small areas. May be uniform or highly localized.

Why you can conquer all four kinds of corrosion with Goulds chemical pumps

When you buy Goulds Fig. 3715 chemical pumps you can build *specific* protection against all four types of corrosion.

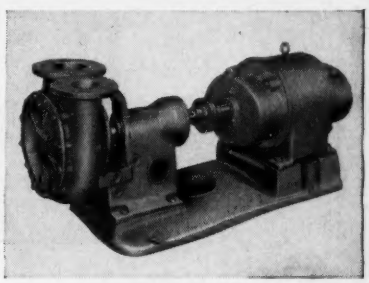
Match the pump metal to your liquids. You can have the *entire* fluid end of the pump made of 316 stainless, Gould-A-Loy 20, nickel aluminum bronze, iron, iron with stainless trim or nickel aluminum bronze trim. These metals from stock. Any machinable alloy on application.

All machined parts in all metals held to same close clearances permitting economical alloy changes in the field . . . the entire liquid end or any component as conditions warrant.

Choosing from this wide range of metals, you can combat the different corrosive actions of hot acids, alkalies, slurries, sizes, or whatever other corrosive liquids you pump.

Match pump size to job

You can get Goulds Fig. 3715 in 9 sizes: capacities to 720 GPM, heads to 200 ft. Other features of Fig. 3715: water-jacketed support head permits handling liquids at 350°F.; impeller clearance can be adjusted without dismantling the pump. For more information, write for Bulletin 720.4.



These larger pumps also fight corrosion

For larger capacities or heads, you can get these other Goulds pumps in metals that resist specific corrosion:

Fig. 3405—single stage, double suction; 19 sizes; capacity to 6400 GPM, head to 425 ft. Bulletin 721.6. Popular sizes available in 316 stainless steel from stock.

Fig. 3305—two stage, opposed impellers; 8 sizes; capacity to 1200 GPM, head to 1000 ft. Bulletin 722.6.

Fig. 3189—single stage, open impeller; 11 sizes; capacity to 1080 GPM, head to 180 ft. Bulletin 720.4.

Goulds PUMPS INC. Seneca Falls New York

Branches: Atlanta • Boston Chicago • Houston New York • Philadelphia Pittsburgh • Tulsa

West Coast Representative: Goulds Pumps Western, Portland, Ore.
In Canada: The A. R. Williams Machinery Co., Ltd. in all principal cities.

TOTE SYSTEM*

FILL IT
a complete bulk materials handling system—aluminum, stainless or carbon steel bins plus filling and discharging equipment
STORE IT
TOTE IT
DISCHARGE IT

first...

- To bring you a new, more efficient method of bulk materials handling
- In number of installations
- In sanitation
- In flexibility
- In compactness
- In savings
- To offer the CONTAINER CAR which simply and cheaply solves bulk delivery problems of off-rail users

Want to know how Tote System fits your picture? Write for illustrated literature, or ask for a survey by Tote engineers. No obligation.

TOTE SYSTEM, INC.

*Tote and Tote System Reg. U.S. Pat. Off.

600 So. 7th, Beatrice, Nebraska

LITERATURE . . .

Bag Closers.....Circular gives details on new Class 2100 portable electric bag closer. Ideal for limited or intermittent operations, unit closes bags of cotton burlap, jute, multiwall or laminated paper.
474A Union Special Machine Co.

Belts, Conveyor, Woven Wire.....Slab, sheet, pelletized and coarse granular materials can be continuously washed, dried, heated or cooled while moving on woven wire conveyor belts. 130 p. manual.
328 *Cambridge Wire Cloth Co.

Belts, V.....Bulletin covers construction details and data on sizes, pitch lengths and outside lengths. Company makes complete information available in Product Bulletin A-606. Request your copy.
323c *Dodge Mfg. Corp.

Boxes, Corrugated.....Reduction of packaging cost is detailed in "How to Ship More Economically in Corrugated Boxes". Included in the 24-page booklet are advice on packages and shipping department layout.
474B Hinde & Dauch.

Chains, Bushed Roller.....Features, applications and selection data on bushed roller chain are detailed in Book 2454. They are manufactured in two designs . . . straight or offset sidebars.
474C Link-Belt Co.

Clamps, Lift Truck.....New line of clamping attachments augments previous line for fork-lift trucks. Photos show clamps, sideshifting clamps, rotators and rotating clamps. Dimensions and specs.
474D Allis-Chalmers Mfg. Co.

Conveyors.....Standard conveyor systems keep heavy, bulky commodities moving with minimum manpower and time loss. Systems can be job-tailored to any specific materials handling problem. Bulletin 309.
352 *Standard Conveyor Co.

Conveyors, Oscillating ..... Complete guide to correct selection and application of stock size Coilmount oscillating conveyors is contained in new book 2644. Dimensions and specs. for stock components.
474E Link-Belt Co.

Conveyors, Screw — Components..... New related ball bearing equipment (trough ends, hangers, etc.) that has been added to company's screw conveyor component line is described in new 6 p. Folder 2489.
474F Link-Belt Co.

Cylinders, Compressed Gas.....Lightweight Hackney cylinders save freight . . . help you tackle higher shipping costs. Offer rigid inspection, uniformity, durability. Specification sheets.
15 *Pressed Steel Tank Co.

Feeder-Conveyor-Elevator ..... Bulk-Flo is endless chain with spaced solid flights in closs-fitting enclosure, for moving free-flowing materials in horizontal, inclined, and vertical directions. Book 2475.
474G Link-Belt Co.

Feeders, Diaphragm ..... Economical, wall-mounted diaphragm feeder described in Bulletin 1913 handles concentrated chemicals directly from shipping containers for greater safety and efficiency.
474H Proportioneers, Inc.

* From advertisement, this issue

Feeders, Rotary.....Type B rotary feeder for heavy duty materials handling is described in data sheet DVc. Photos and cut-away dwgs. show simple design and construction of unit. Selection aids.
475A Allen-Sherman-Hoff Co.

Feeders, Volumetric.....Rotodip Model 65 discussed in Bulletin 65-H12B is a rotary volumetric feeder with simplified design. Features described and illustrated including typical installation.
475B Omega Machine Co.

Kettles, Resin.....Bulletin LB-1 describes in detail the Brighton line of laboratory and pilot model synthetic resin kettles. Units are complete with coolers, heaters, condensers and controls.
475C Brighton Corp.

Loaders, Palletless.....New bulletin covers push-pull loader with integral sideshift which is used for palletless loading. Specifications on fork-truck attachment are accompanied by procedure for use.
475D Yale & Towne Mfg. Co.

Loaders, Tractor.....Compact Tractomotive TL-6 Tracto-Loader quickly unloads boxcars, travels through narrow aisles and doorways, makes hairpin turns around columns and posts. Request product bulletin.
73 *Tractomotive Corp.

Materials Handling Systems.....Bring you new, more efficient method of bulk materials handling . . . in number of installations, in sanitation, in flexibility, in compactness, in savings. Literature.
474 *Tote System.

Tractor-Shovels.....HA "Payloader" and larger model HAH do the work of four previous units. Ideal for any bulk materials you have to scoop-up, load or spread. Details available upon request.
224-5 *Frank G. Hough Co.

Transports, Tank.....Literature discusses new line of chemical and acid tank transports. Novel external ring design permits light weight construction which meets ICC regulations MC-311 and ASME code.
475E Doyle & Roth Mfg. Co.

Trucks, Electric Fork.....Four-page folder describes model F-48T3, 3,000-lb capacity fork truck designed for low-headroom operation. Complete design information and specifications included.
475F Elwell-Parker Electric Co.

Trucks, Industrial.....Design, engineering, construction and operating features of fork-lift trucks, towing tractors and platform trucks are described in 20-page catalog BU-305 now available.
475G Allis-Chalmers Mfg. Co.

Vessels, Jacketed.....Choice of standard designs from which you can select jacketed reactors or kettles from 5 to 2000 gallons. Bulletin spells out sizes and detailed specifications Request Bulletin 904.
4th Cov. *Pfaulder Co.

Vibrators.....Movement of granular solids with the Peterson Vibrolator is detailed in new 36-page catalog. Line dwgs. suggest a variety of mountings. Specifications and performance data are listed.
475H Martin Engineering Co.

* From advertisement, this issue

CANADA DRY

"CANADA DRY BEVERAGES CHOOSE E-D FILTER PAPERS TO GET SPARKLE AND PURITY!"

J. L. Murphy, Jr., Vice-President in charge of production for Canada Dry Ginger Ale, Inc.

"For 30 years, we have used Eaton-Dikeman filter papers to obtain the sparkle and purity that are essential in maintaining the quality for which Canada Dry Beverages are known and liked", says Mr. J. L. Murphy.

"Our beverages are sold to millions of consumers each year. They are a discriminating and exacting jury. Clarity, flavor, sparkle must be up to top standards at all times to hold their loyalty. Thus, in the final stages of polish filtration, we must have a *dependable* and *uniform* filter medium. We have found that Eaton-Dikeman filter paper, year in and year out, fulfills these requirements.

"In addition to fine porosity, E-D filter paper has very high rapidity, which is a requisite for maintaining the high production rate of Canada Dry Beverages.

"Filtration is a very important part of our operation. Every bottle that leaves our plant must be sparkling, clear and pure. E-D filter paper helps us uphold these standards."

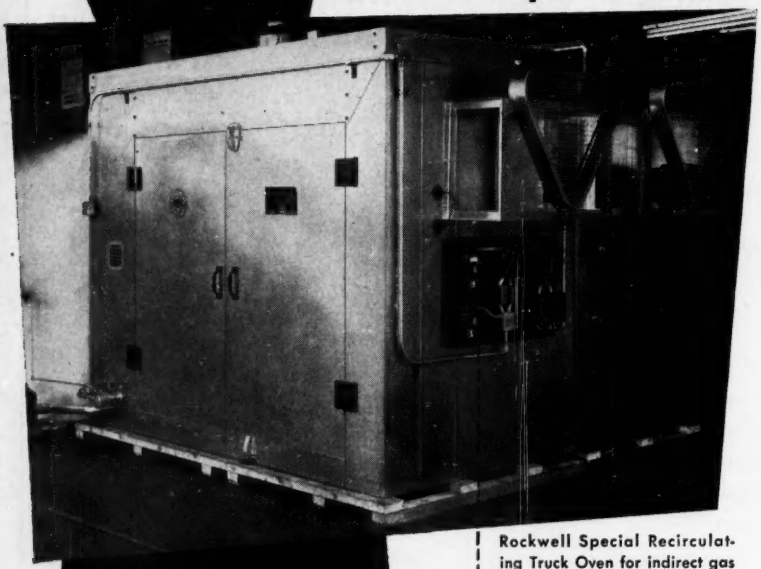
To get maximum clarity for *your* filtration, let us recommend the grade you ought to try. E-D samples for test runs gladly furnished without obligation.

E D *The Eaton-Dikeman Company*

FILTERTOWN
MOUNT HOLLY SPRINGS, PENNSYLVANIA

XUM

w. s. rockwell company depends on partlow controls for accurate oven temperatures



Rockwell Special Recirculating Truck Oven for indirect gas heating to 500°F. . . . with Partlow M2 Electric Indicating Control, and 02 Limit Control.

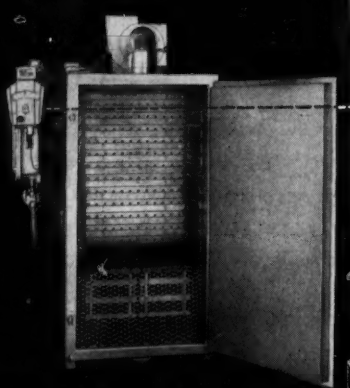
partlow

W. S. Rockwell Co., Fairfield, Conn., one of the oldest builders of industrial ovens, specifies Partlow Controls to insure the high standard of performance for which their ovens are famous.

There's a Partlow control . . . in the –30°F. to 1200°F. range . . . for use on your own product or in your manufacturing operations.

Available for use with gas, oil, steam or water valves; or electrical equipment.

Rockwell Standard Bench Oven with Partlow M2 Electric Indicating Control . . . range 50° to 350°F.



Rockwell Recirculating Bench Oven with Partlow LVS explosion-proof Indicating Electric Control . . . range 100° to 350° F.

partlow

the pioneer in mercury thermal controls

SEND FOR CONDENSED CATALOG

THE PARTLOW CORP.

Dept. E-457

NEW HARTFORD, N. Y.

Offices in All Principal Cities

LITERATURE . . .

Heating & Cooling

Burners, Combination....Thermal vortex burner described in Bulletin III features integral construction of burner and combustion chamber. Operates on residual fuel oil and other fuels.
476A Thermal Research & Eng'g.

Coils, Plate....Platecoil simplicity saves engineering, fabricating, installation, operation and maintenance costs in heat transfer. Units are compact and lightweight. Full details available in Bulletin P-61.
84 Tranter Mfg.

Coolers, Liquid.....Packaged liquid coolers include a complete refrigeration cycle, compressor, motor and starter, refrigerant controls, liquid cooler, condenser, piping, wiring and insulation, etc. Request catalog.
476B Doyle & Roth Mfg. Co.

Coolers, Pellet ..... Coolaire pellet cooler and dryer described in bulletin 119 is simple, effective unit to handle pellets quickly and efficiently with minimum leakage of fines or dust.
476C Sprout-Waldron.

Cooling Equipment.. ..Company offers economy and reliability in cooling equipment for air conditioning, process work, ice making, quick freezing and other refrigerating purposes. Full details in catalog.
485 *Frick Co.

Dehydrating Systems, Caustic....Booklet SW-203 tells how system cuts installation and operational costs to less than half those for comparable pot-type system. Flow sheet details components and features.
52-3e Swenson Evaporator Co.

Evaporation......"An Open Door" tells about unit operations such as evaporation, crystallization filtration, pulp washing & spray drying as a means to reduced costs & improved quality. Bul. SW-100.
52-3a Swenson Evaporator Co.

Evaporators....."Evaporators For Recovery of Mercerizing Caustic" gives information on design, application, operation and construction of this type of evaporator. Details in Bulletin SW-201.
52-3c Swenson Evaporator Co.

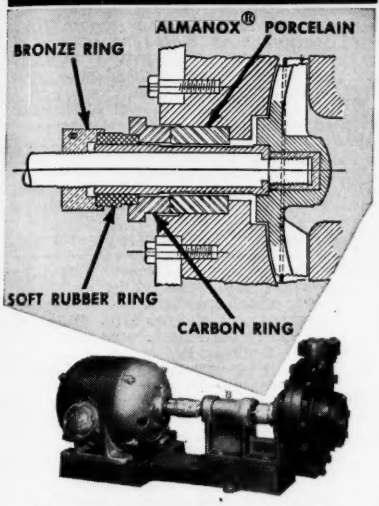
Evaporators, Phosporic Acid.....These evaporators feature: simple, compact design; time-proven, reliable; easy to operate; corrosion resistant; low maintenance; no fumes. Bulletin No. SW-202.
52-3d *Swenson Evaporator Co.

Generators, Steam.....Book gives capacities, dimensions, construction features, instrumentation, accessories, sectional drawings & installation photos on new series of steam generators. Bulletin PG-55-3.
159 *Foster Wheeler Corp.

Heat Exchangers.....The Alcotwin heat exchanger furnishes real economy in first cost, in ease of installation and maintenance. Unlimited adaptability prevents obsolescence. Details available in Bulletin FH-3.
408 *Alco Products.

* From advertisement, this issue

LUZERNE
HARD RUBBER
PUMP
WITH IMPROVED SEAL
Will Solve Your Corrosion Problems



How This Improved Seal Works

New mechanical seal on all Luzerne Pumps is made by using a revolving carbon ring against a stationary almanox® porcelain ring. This permits a rubber covering on the metal shaft and eliminates usual packing troubles due to friction and leaking of conventional packing.

® Frenchtown Porcelain Co. Trade Mark

OTHER FEATURES

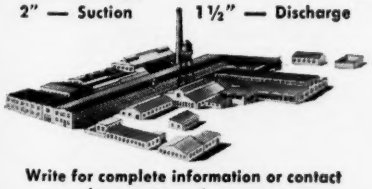
- Complete resistance to wide range of corrosives
- Available in heat resistant Buna-N synthetic rubber compounds for temperatures up to 225° F.

SPECIFICATIONS

Style A — Open impeller pump — 140 gallons per minute at 90 foot head maximum.

Style B — Open or closed impeller pump — 115 gallons per minute at 68 foot head maximum.

2" — Suction 1½" — Discharge



Write for complete information or contact our sales representative nearest you.

The LUZERNE RUBBER CO.

100 Muirhead Avenue Trenton, N. J.

— Sales Representatives —

ALBERT J. COX CO. Chicago, Ill. R. C. FOLTZ CO. Houston, Tex.

L. A. RUBBER & ASBESTOS WORKS Los Angeles, Calif.

FILTRATION *Engineered** TO MEET CHEMICAL PROCESSING NEEDS

CUNO

A Complete Line of Filters Including —

PORO-KLEAN

THE POROUS STAINLESS STEEL MEDIUM FOR LIQUIDS, GASES AND STEAM THAT COMBINES ALL THESE UNUSUAL FILTRATION CHARACTERISTICS —

- **HIGH HEAT RESISTANCE** . . . for operating temperatures as high as 900°F.
- **HIGH TENSILE STRENGTH** . . . to 15,000 psi, able to withstand differential pressures of more than 3500 psi.
- **HIGH CORROSION RESISTANCE** . . . allowing filtration of — or cleaning by — substances that would quickly damage other filter materials.
- **UNIFORM FINE FILTRATION** . . . with standard material down to 5 microns and material for sub-micronic filtration on special order.
- **NO MEDIA DISCHARGE** . . . Independent tests *prove* no product contamination even under conditions of extremely high differential pressures and severe vibration.
- **AVAILABLE** . . . as cartridge-type filters and as specially fabricated or preformed elements. A complete line of standard or special high pressure coded Cuno Housings are available.

*Because no *one* type of filter is best for every need, Cuno — and *only* Cuno — offers you a truly complete line that includes *several* distinct types of filtration media. And because every filtration system must be specified and engineered to individual job requirements, Cuno also offers you a complete application engineering service through the Cuno Field Engineer. Conveniently located in your area, one of these specialists is ready and fully qualified to help select the filter type and model exactly right to solve your problems.

WRITE NOW FOR COMPLETE INFORMATION

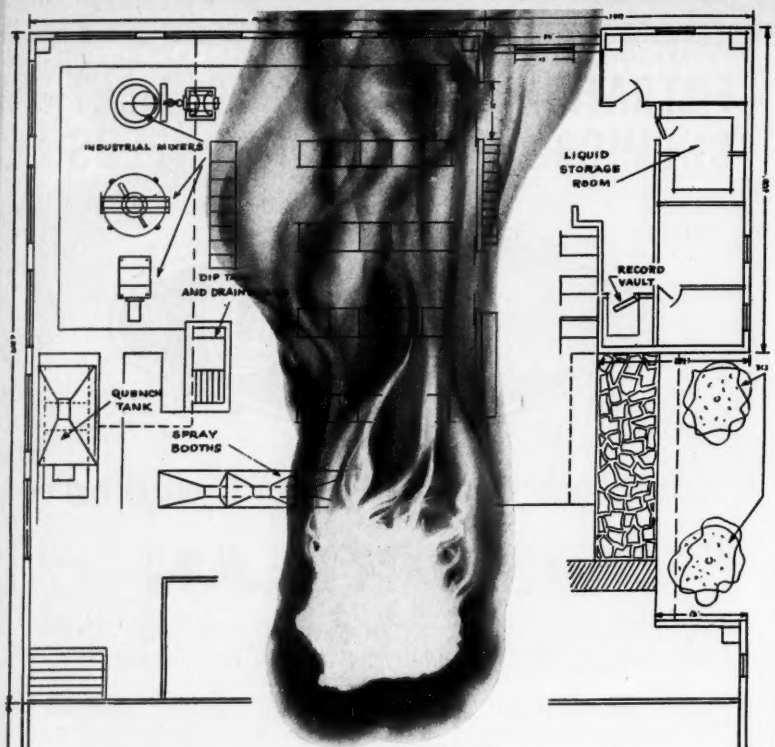
CUNO ENGINEERING CORPORATION

304 SOUTH VINE STREET, MERIDEN, CONN.

TELEPHONE: BEverly 7-5541

EDGE-TYPE, WIRE-WOUND, SCREEN, FIBER CARTRIDGE and POROUS METAL FILTERS

Filtration Engineers in Principal Cities



Where will FIRE start in your plant?

Whatever the hazard, dip tanks, record storage vaults, spray booths, Kidde's carbon dioxide fire extinguishing system protects your plant 24 hours a day, gives you the fastest, safest fire protection ever made! Product of more than thirty years' experience, the Kidde system boasts more features than any other make on the market today. Features like:

All operating parts completely enclosed to guard against fouling or accidental operation.
No clumsy triggering methods or falling weights.
Self-contained; no outside power needed.
Visual indicators to show if system has been operated.
Easy testing of all operating parts.
No parts to replace after operation or test.

Fast-acting, clean carbon dioxide does the job that no other extinguishing agent can do: snuffs fire out in seconds, then vanishes into thin air. Won't harm valuable machinery, leaves no mess to clean up. Write for Kidde's pressure operated carbon dioxide fire extinguishing systems booklet today.

Kidde (K Kidde) **Walter Kidde & Company, Inc.**
428 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd., Montreal—Toronto

LITERATURE . . .

Heat Exchangers.....How a Paracoil obstacle course gives you better heat exchange. Davis will create the proper turbulence to give you most effecient heat transfer in equipment. Request Bulletin 1000.
482 *Davis Engrg. Corp.

Heat Exchangers . . . . . Explains the functions of new equipment to provide cooling of liquids in industrial plants independent of a large supply of cooling water and with additional savings. Bulletin 132.
358 Niagara Blower Co.

Heat Exchangers.....The patented Ell Bolt construction employed on Vogt floating head heat exchangers is the answer to reassembly without distortion or leak development. Request Bulletin No. HE-6.
285 *Henry Vogt Mach. Co.

Heat Exchangers, Acid Resistant..... Important data on Swenson type of tube mounting, types of corrosion resistant materials and advantages of neoprene ring gaskets available in Bulletin SW-200.
52-3b *Swenson Evaporator Co.

Heat Exchangers, Shell & Tube..... Pyrex brand glass shell and tube units offer: resistance to corrosion, elimination of foreign material, simplicity of design, easy maintenance. Bulletin PE-33.
56-7 *Corning Glass Works.

Heat Exchangers, Shell & Tube..... Bulletin describes shell and tube heat exchange equipment. Outlines construction features, general specifications and standard materials for this equipment. Bulletin No. HE-1.
478A Heat Transfer Co.

Heat Transfer Equipment.....Partial list of material processed with A-C heat transfer equipment: limestone, lime, dolomite, magnesia, alumina, bauxite, manganese oxide, iron ore, etc. Bul. 25C6177.
381 *Allis-Chalmers Mfg. Co.

Heat Transfer Systems.....Capacities can range from small portable units to large gas- or oil-fired units generating from 250,000 to over 10,000,000 B.T.U.'s per hour. Names of designers & manufacturers.
399b *Monsanto Chem. Co.

Heat Treating.....New Bulletin explains the economic features of completely mechanized heat treat lines. It is a comprehensive commentary on mechanized heat treating. See Bulletin SC-176.
478B Surface Combustion Corp.

Heaters, Air.....Peabody units are custom-engineered to individual job specifications. Compact and flexible in design, simple in operation. Require little space, attention or maintenance. Bul. 600A.
469 *Peabody Engrg. Corp.

* From advertisement, this issue

Any bulletin or catalog . . . yours for the asking

You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

Heaters, Circulation.....New 8 p. bulletin describes Chromalox automatic electric circulation heaters, for controlled heating of water, oils, heat transfer media, steam, air and other gases. Bulletin 701.
108 Edwin L. Wiegand Co.

Heaters, Dielectric.....Line of dielectric heaters for non-conducting materials extends from a 3-kw unit to 100-kw and larger machines. May be equipped with oven, cages, conveyors. Bulletin 15B6431C.
229 *Allis-Chalmers Mfg. Co.

Heaters, Gradiation.....Makes available detailed literature—"Try the Gradiation Heater for Economical Ethylene Production" and Bulletin 104, "Gradiation Heating for Petroleum and Chemical Processing."
372 *Selas Corp. of America.

Heaters, Liquid.....System for heating liquid heat-transfer medium is described in Catalog 162. Operating at atmospheric pressure, system supplies accurately controlled indirect heat.
479A S. Morgan Smith Co.

Humidifying Systems ..... All units needed for industrial humidifying systems, other than piping and wiring, are illustrated and described in Bulletin 82. Centralized listing simplifies buying problems.
479B Spraying Systems Co.

Ovens.....Company offers illustrated bulletin describing laboratory and production ovens. Includes ratings, accessory information, features, diagrams applications and specifications. Bulletin No. 100.
T511 Despatch Oven Co.

Tandem Combustion Units, Oil-Gas.... You will realize higher profits from your heaters when National Airoil vertical or horizontal tandem units are specified. For full details, request Bulletin No. 498.
494 *National Airoil Burner Co.

Thermometer Elements, Resistance.... Answer industry's need for a better way to measure surface temperatures, Flexible, easy to apply, low cost, fast response. Full details in Brochure No. T-56.
B514 *Arthur C. Ruge Assoc.

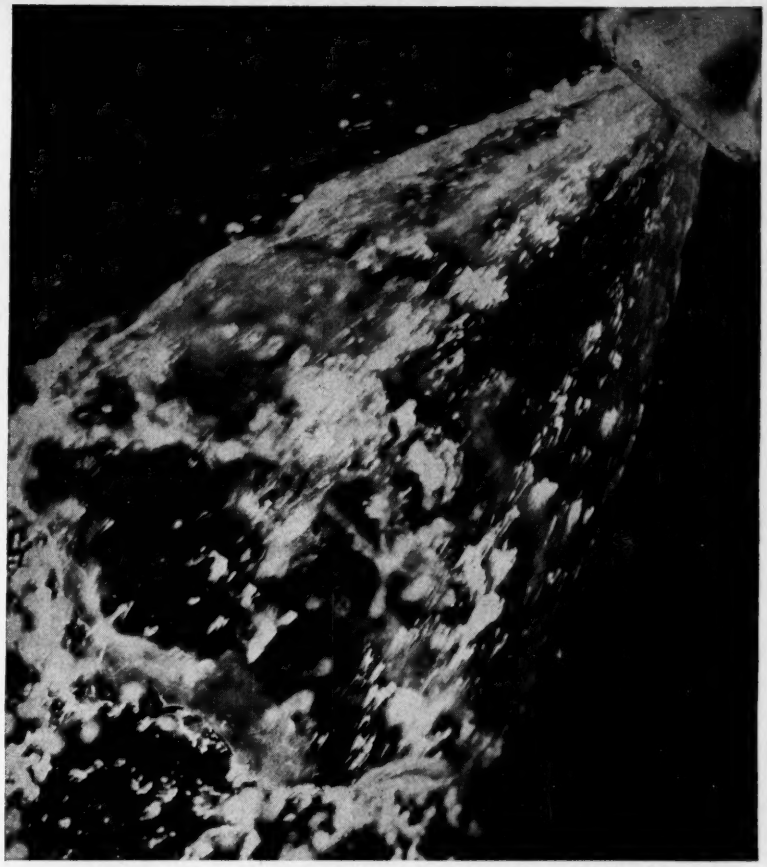
Thermo-Panels.....Cost less and perform better—an improvement on pipe coils. Save space and heat or cool more efficiently. For use in heating and cooling of liquids, slurries, etc. Bulletins 355 and 257.
TR516 *Dean Thermo-Panel Div.

Towers, Cooling.....High cooling efficiency, low drift losses and rugged, construction of new line of FW induced draft cooling towers mean lasting economy and dependability in service. Bul. CT-56-11.
289 *Foster Wheeler Corp.

Traps, Steam.....Major reductions in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap—permits standardized hookups. Steam Trap Book.
391 *Armstrong Machine Works.

Traps, Steam ..... Yarway Impulse Steam Traps feature: small size-lightweight; only one moving part; stainless steel; won't freeze up. For information, request Trap Selector, Bulletin and Diagram.
401 *Yarnall-Waring Co.

*From advertisement, this issue



To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

Controlling Volume in Fluid Engineering

Few volume control problems can be solved with a quick twist of your wrist the way you do with a garden hose nozzle. In processing equipment, the factors of pressure, flow, and time must also be carefully considered. That's why, when you need accurate answers, you can depend on the broad engineering background S. Morgan Smith offers.

Take an SMS Rotovalve, for instance. Its full line opening means least head loss, lower pumping costs. Hydraulic imbalance and mechanical design make the Rotovalve easy to operate. Fast initial shut-off limits reversal of flow, and closing can be in one second or as slow as required. Final closure is positive and drop tight throughout valve life. SMS Ball Valves, similar to Rotovalves, offer many of these same advantages.

Information on the complete SMS line – R-S Butterfly Valves, Rotovalves and Ball Valves may be obtained by calling our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special, engineered applications.

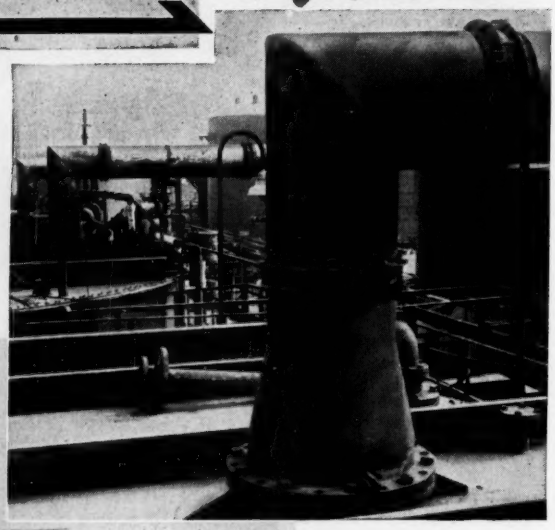
SMS S. MORGAN SMITH HYDRODYNAMICS

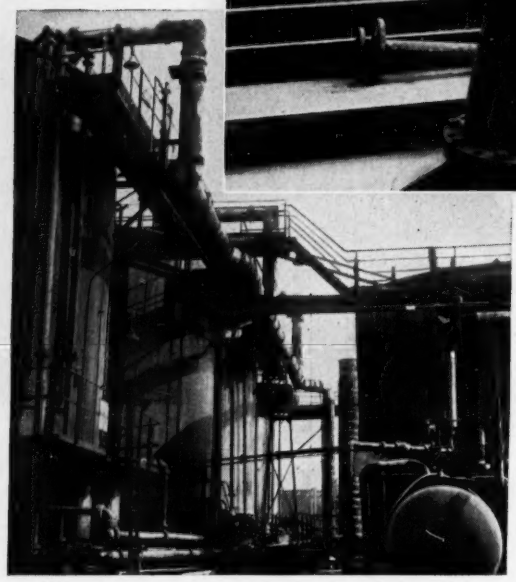
AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

HAVEG® News

Wherever CORROSION RESISTANCE is a Factor...





HAVEG DUCT solves SO_2 fume removal problems

RESISTANCE TO ACID ATTACK MAKES THE DIFFERENCE AT ATLANTIC REFINING COMPANY ACID PLANT

Production of 150,000 lbs. of sulphuric acid daily posed a major corrosion problem for Atlantic Refining Company at its Philadelphia plant. Vapors boiled off from refinery sludges during recycling operations in the recovery plant contain SO_2 concentration as high as 65% ... at temperatures up to 250°F! After testing several materials for required properties, Haveg 41 was selected for installation of the fume duct and scrubbing system pictured above. The result? No evidence of corrosion—after more than two years of continuous operation!

Haveg Performance Proved by Experience

Three 18" ducts feeding into an 18" header carry the gas to a scrubber 36" in diameter and 29' in height, also constructed of Haveg 41. Since installation of the Haveg fume removal and scrubbing system external corrosion of other equipment has been substantially reduced. Elsewhere at the plant Haveg pipe, processing vessels and duct installations have proved Haveg's exceptional resistance to corrosion, physical strength and thermal versatility for over 15 years of superior performance.

A Haveg Plastic for Every Service Requirement

No other material offers as wide a range of effective resistance to corrosive acids, hypochlorites, salts, alkalies, and solvents as the Haveg plastics. Custom design and field service assures you full advantage of Haveg's low net cost for every process installation. Let a qualified Haveg corrosion engineer help you determine the Haveg plastic and equipment design best suited for your needs ... or write for Haveg Bulletins describing the complete line of corrosion resistant equipment.

H-701

HAVEG PLASTICS OF TOMORROW SOLVE YOUR CORROSION PROBLEMS TODAY IN PIPING • PUMPS • PROCESS TANKS • FUME DUCTS • VALVES • HEAT EXCHANGERS

HAVEG INDUSTRIES, INC. 922 Greenbank Road, Wilmington 8, Delaware Factory: Marshallton, Del. Phone WYman 8-2271

Atlanta, Cedar 7-3821 • Chicago (Wheaton), WHeaton 8-3225 • Cleveland, WAshington 1-8700 • Detroit (Livonia), KEnwood 1-1785 • Houston (Bellaire), MOhawk 7-6519 • Los Angeles • New York (Westfield, N.J.), WEstfield 2-7383 • Seattle, Main 9006 • Denver, BEImont 7-0433 • Canada: Montreal, GLenview 7791 • Toronto, RUssell 1-5559 • Monterrey, Mexico

LITERATURE . . .

Washers, Pulp.....Pulp washers for the neutral sulphite semi-chemical pulping process. Advance design features will reduce pulp washing and evaporation costs. Full details in Bulletin SW-300.
52-3f *Swenson Evaporator Co.

Instruments & Controls

Analyzers, Infrared.....M-S-A LIRA Model 200 infrared analyzer provides automatic, continuous, high-speed, accurate analysis for a single component in a simple or complex mixture of gases or liquids. Book.
87 *Mine Safe Appliances Co.

Analyzers, Oxygen.....Bulletin 1841 reports that the Type 38-301 oxygen analyzer detects and measures trace amounts of oxygen in process gas streams. Instrument is a colorimetric differential photometer.
480A Consolidated Electrodynamics.

Analyzers, Ultraviolet.....For continuous monitoring and control of petroleum, petrochemical and allied processes, the Type 38-401 ultraviolet analyzer is rugged and stable reports Bulletin 1842.
480B Consolidated Electrodynamics.

Borescopes ..... Zeiss-Kollmorgen Models TG-1, TG-2 and TG-5 Borescopes are described in bulletin. They are instruments for visual close-up inspection and examination of internal areas.
480C Kollmorgan Optical Co.

Chromatograph ..... Operates with either adsorption, gas-liquid partition, or reaction columns. Microsampling makes instrument practical for all types of laboratories. See Bulletin CEC 1831-X17.
69 *Consolidated Electrodynamics.

Chromagraph ..... Model 1111A Chromagraph analytical instrument described in 4-page bulletin is a mobilized unitized instrument based on Shell Development Co. experience analyzing gases and liquids.
480D Hallikainen Instruments.

Computers, Digital.....Bulletin AB116 describes G-15D general purpose digital computer and accessory digital differential analyzer. Also covers new programming techniques and input-output equipment.
480E Bendix Aviation Corp.

Control Systems.....ElectroSyn system described in technical bulletin B257 is a non-electronic signal generator system that measures, indicates, transmits and controls many process variables.
480F Norwood Controls.

Controllers, Potentiometer ..... Series 150 non-indicating potentiometer controller described in Bulletin F-7298 is designed for control applications encountered in batch processes.
480G Barber-Colman Co.

Controls.....Blanks undergo 3-hour curing cycle . . . are brought slowly from rom temperature to 320°F., then held there for 1½ hours. Partlow controls are used in several H-1 operations. Condensed Catalog.
476 *Partlow Corp.

* From advertisement, this issue

Controls, Pressure & Vacuum..... Types H5 and H12 accurately and sensitively control liquid level alarms and air gas pressures. H5 controls up to 500 psi and H12 up to 180 psi. Bulletins 5-5 and 5-2.
464 *United Elec. Controls Co.

Controls, Temperature.....Model H2 direct-acting temperature control keeps equipment below preset temperature limits, according to Bulletin RT-809. Mechanism and installation fully illustrated.
481A Robertshaw Fulton Controls.

Counters, Electric.....Up to 200 counts per min. are recorded by a new electric counter described in Technical Reference 56-C. Device counts packages or objects that move past check point.
481B Richardson Scale Co.

Data Systems.....Reprint R-98 entitled "Increased Reliability of Industrial Data Systems" traces the development of the industrial data system and forecasts its future role in closed-loop systems.
481C Beckman Instruments.

Gages.....New line of small-size gages feature: 5 inch illuminated scales; independent, interchangeable units; multiple or individual mounting; easily mounted; pointer motion reversible. Bulletin V5.
104 *Republic Flow Meters Co.

Gages, Vacuum.....Data sheet 9-31 gives details on the Type 2203-03 Pirani vacuum gage that features a new sensing tube which greatly reduces zero drift. Suitable for 1 to 4 stations from 1 to 2,000 microns.
481D Consolidated Electrodynamics.

Indicators, Smoke.....New improved smoke indicator and indicator-recorder, Type EHA, is described in Bulletin 30. Smoke density sensed by photoelectric cell is translated into meter reading.
481E Brooke Engineering Co.

Indicators, Stabilized pH.....Offer these advantages: quick warm-up; fast response; measuring errors "designed out;" only two adjustments; fine performance. Information in Data Sheet E-96(2).
66 *Leeds & Northrup.

Instruments, temperature Regulator.....Designed for precise temperature control, Powers No. 11 regulator is self-powered . . . simple compact and dependable. Complete details available in Bulletins 329. 330.
L499 *Powers Regulator Co.

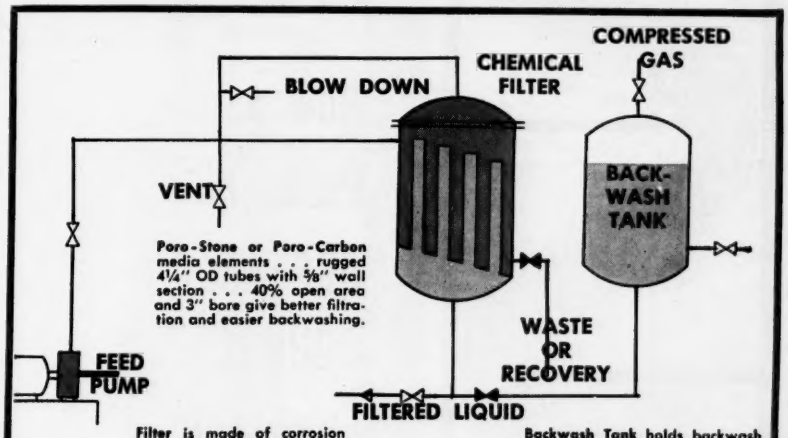
Meters, Flow.....Positive displacement type described in Bulletin 400 is suitable for hard-to-handle liquids such as bunker oils, still bottoms and asphalt. In sizes from 1 to 6 in. or up to 450 gpm.
481F Brooks Rotometer Co.

Meters, pH.....New Zeromatic (T. M.) pH meter described in Bulletin 705 is an automatic push button instrument with drift-free amplifier. It's ready to operate at the touch of a button.
481G Beckman Instruments.

Meters, Valves, Regulators.....Completely revised, condensed 28-page catalog C-5000, Rev. 8 for the Rockwell line is completely restyled with more photo illustrations of all products.
481H Rockwell Mfg. Co.

*From advertisement, this issue

ADAMS BACKWASH DESIGN
can lower your filter labor costs...


COMPRESSED GAS
CHEMICAL FILTER
BLOW DOWN
VENT
BACK-WASH TANK
Poro-Stone or Poro-Carbon media elements . . . rugged 4¼" OD tubes with ⅜" wall section . . . 40% open area and 3" bore give better filtration and easier backwashing.
WASTE OR RECOVERY
FEED PUMP
FILTERED LIQUID
Filter is made of corrosion resistant alloys to meet process requirements. Note: Complete drainage from shell of filter cake after backwashing is obtained by sloping tube sheet.
Backwash Tank holds backwash liquid under head of compressed gas. Backwash liquid is forced back through filter in reverse flow at high velocities to clean filter in less than ½ minute. Note: no disassembly for cleaning.

TYPICAL BACKWASH FILTER CLEANING CYCLE

There are numerous filters which will meet the needs of your particular process. Your problem has become . . . "Which one shall I buy?"

Doubtlessly, there are other units which will produce as clear an effluent as the Adams filters. So the choice would seem to narrow down to initial investment. Here you will find Adams filters competitive in price.

What about operating and maintenance costs? That's where the Adams filter can save you money!

You clean your Adams filter by operating a few valves . . . no time consuming and often dangerous manual disassembly and cleaning necessary. Your filter is off-stream for as little as two minutes and seldom over 15. The liquid required for cleaning is only a small fraction of that needed by other filters using the reverse flow technique. And what's more, you get thorough cleaning. The Backwash liquid is easily recovered if necessary.

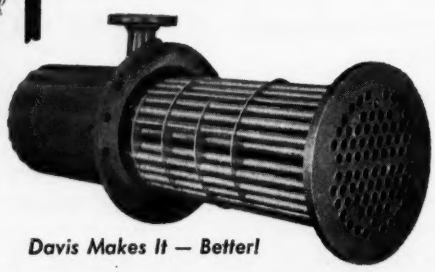
R. P. ADAMS CO., INC.
207 E. PARK DRIVE • BUFFALO 17, N. Y.

R. P. ADAMS COMPANY, INC. A-57
207 East Park Drive
Buffalo 17, N. Y.

Gentlemen:
We have a problem in chemical filtration. Please send us your Bulletin 431.

Name..... Title.....
Firm.....
City..... State.....

How a Paracoil OBSTACLE COURSE gives you better heat exchange



Davis Makes It — Better!

Paracoil Type "P" Exchanger, 2-Pass Type, Stationary Head End. Tube bundle partially withdrawn, showing segmental baffles. Note close tolerances between tubes and baffles, and between baffles and shell. Close baffle tolerances assure higher heat transfer rates.

Tumble the liquid . . . keep it baffled . . . make it take the long way home . . . that's what Davis will do to create proper turbulence to give you the most efficient heat transfer in equipment designed for your needs. And, we know just how to do it.

Our engineers have been designing equipment for chemical process industries, industrial process application, power plants, utilities and marine projects since 1915.

Write for Bulletin 1000

DAVIS ENGINEERING CORPORATION

30 Rockefeller Plaza, New York 20, New York Circle 6-5650

1064 East Grand Street, Elizabeth 4, New Jersey ELizabeth 2-6780

LITERATURE . . .

Monitors, Radiation....."The Victoreen Remote Area Monitoring System" described in Bulletin 3045 consists of basic control unit, plug-in station units and sensing elements. Copies available on request.
482A Victoreen Instrument Co.

Optical Instruments.....Booklet "Industrial Optical Aids" gives up-to-date information on many inexpensive precision optical instruments and tells how they can be used to advantage.
482B Bausch & Lomb Optical Co.

Periscopes, Industrial.....Offer these periscopes for special assignments in remote viewing. Bulletin 301 gives step-by-step analysis: location of viewing head, location of eyepiece, body tube, etc.
482C Kollmorgen Optical Co.

Power Supplies.....For the new high-intensity, zirconium-enclosed concentrated arc lamp, a new power supply provides most efficient operation, according to technical bulletin PS-1.
482D Electron Arc.

Pyrocons, Portable.....Compact in size, complete in precision design and workmanship, these rugged instruments assure highest standards of speed, accuracy and dependability. Details in Bulletin 4257.
L497 *Illinois Testing Labs.

Recorders.....Offer valuable features: pre-calibrated plug-in receiver units; up to 4 pneumatic or electronic receivers—or 2 receivers and 2 integrators; etc. Request Product Specification E12-5.
222 *Bailey Meter Co.

Recorders.....8 p. bulletin describes the American Microsen Series 130 Millivoltmeter & Microammeter Recorder. Includes functions, principle of operation, design features, etc. Bulletin MG10.
58 Manning, Maxwell & Moore

Recorders, Multi-Point.....Permanent recording of as many as 16 points on one chart—at standard recording speeds ranging from 3 to 24 inches per hour—on Wheelco Series 8000 recorders. Bul. F-7955.
346 *Barber-Colman Co.

Regulators, Atmospheric ..... Norwalk atmospheric regulators deliver gas to burners at zero pressure and maintain gas-air ratios over a wide range of turn down. Complete details in Bulletin 6000.
482E Norwalk Valve Co.

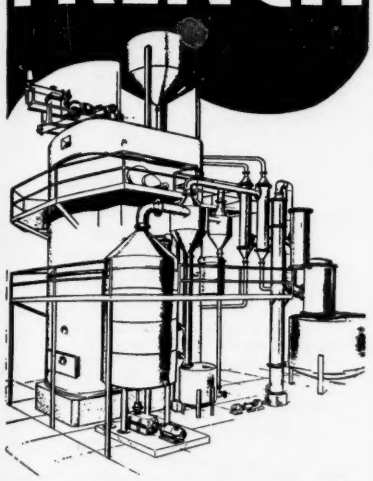
Regulators, Vaporizer.....Cat. No. 38-001 Vaporizer Regulator described in Bulletin 1832 is used with gaseous-type process analyzers and petrochemical monitoring instruments to vaporize sample.
482F Consolidated Electrodynamics.

Regulators, Voltage.....Stabiline automatic voltage regulator will make sure that your electrical equipment operates at its most efficient and economical rating. Full details in Bulletin S657.
107 *Superior Electric Co.

Relays, Pneumatic Computing..... Product Specification P99-3 describes features, application, and operating characteristics of computing relay for pneumatic control systems. Explains various actions.
482G Bailey Meter Co.

* From advertisement, this issue

FRENCH



EXTRACTION

EXPERTS IN REMOVING SOLUBLES FROM SOLIDS

- MINERAL ORES
- PLASTICS
- SCRAP METAL
- SPICES
- ALFALFA
- OIL SEEDS
- ANIMAL TISSUE

PROCESSING WITH FLAMMABLE SOLVENTS

SOLVENT RECOVERY

DEWATERING

For over 50 years, FOMMCO extraction equipment has had an unusual record of achievement of processing economy and efficiency in the animal and vegetable oil milling field. Now . . . the experience, research and technical knowledge of more than a half century of building extraction plants have been turned to the general chemical field.

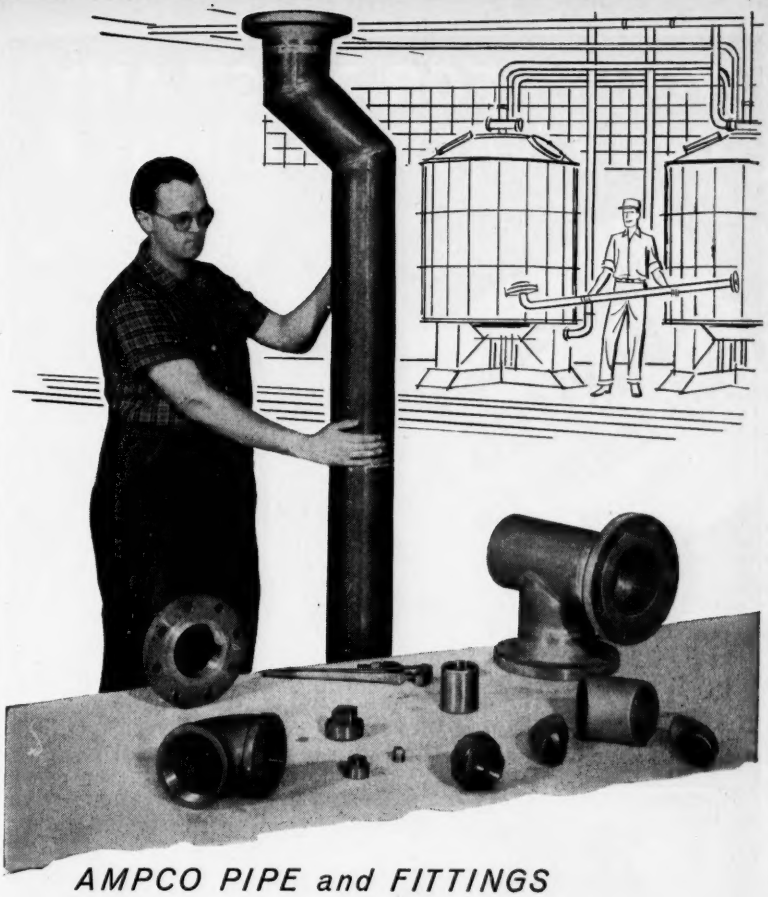
Write today for suggestions in solving your extraction problems.

FO2

THE FRENCH OIL MILL MACHINERY CO.

EXTRACTION DIVISION

PIQUA OHIO



AMPCO PIPE and FITTINGS

resist corrosive action of fatty acid hydrolysis

Ampco Pipe and Fittings resist corrosion, erosion, and cavitation-pitting of a wide range of alkalies and acids

Brinell hardness of 150 — tensiles up to 70,000 psi

High velocity tolerance —flow rates of 18-20 fps

Thread not distorted by wrenches or hammers — no leakage

Ampco Pipe and Fittings are made from a unique aluminum-bronze alloy that takes the trouble out of handling troublesome, corrosive media.

Look at how soapmakers use Ampco Pipe and Fittings, for example. In making soap, a solution of sulphuric acid is added to fatty acids. One company uses Ampco Pipe to transfer this solution from wooden tanks. Another uses Ampco Pipe and Valves — and, in addition, uses tank liners made of Ampco Metal.

You can get Ampco Pipe in all standard sizes, many from stock. Fittings are available to 3000 pounds; flanges, to 5000 pounds.

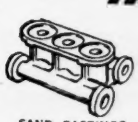
Write us concerning *your* problem.

AMPCO METAL, INC.

Dept. CE-4, Milwaukee 46, Wis. • West Coast Plant: Burbank, Calif.

AMPCO®

THE METAL WITHOUT AN EQUAL



SAND CASTINGS

CAST. FLANGES

FORGINGS

CENTRIFUGAL CASTINGS

EXTRUSIONS

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FABRICATIONS

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MACHINED PARTS

PR-25

YOURS FOR MOST ANY GATE VALVE SERVICE

...The advantages of DARLING fully revolving disc design!

Darling Victaulic end gate valves are made in accordance with specifications to fit standard Victaulic couplings... just one of the many various types of ends offered by Darling to meet your specific installation requirements.

THE Darling *fully revolving, double disc, parallel seat* principle simplifies gate valve operation and cuts maintenance and replacement costs.

Darling offers this type of gate valve in sizes and alloys for practically any service you can name.

Regularly available in iron body, cast steel, rubber lined iron body, all bronze and special alloys . . . for ordinary and unusual services. Made with various type ends to meet your particular installation needs.

Write for complete information on Darling Gate Valves . . . the valves that give you the most dependable, maintenance-free valve service you've *ever* had.

DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

LITERATURE . . .

Thermometer Probe, Resistance..... By utilizing a grid of extremely fine platinum wire welded to platinum lead wires, this probe is capable of operation over the range of from 0 to 1200° C. Bulletin.
484A Arthur C. Ruge Assoc.

Timers.....Type A for applications requiring shorter timing periods, ±15% accuracy and no interlocks; Type B for applications requiring timing periods up to 3 minutes, maximum accuracy. Bulletin 9050.
63 *Square D Co.

Hose Clamps.....In addition to compiling standard hose clamps, grooved hose fittings, special tools and replacement parts, Form Cat. 300RG-56 serves also as an instruction and training manual.
484B Punch-Lok Co.

Venturi Tubes.....For venturi tube design features, comprehensive dimensional data, capacity tables, recovery tables and similar information see new 4-page Bulletin 110-N1. Various constructions.
484C Builders-Providence.

Pipe, Non-metallic.....Line pipe and well tubing made from thermosetting reinforced epoxy resins for light weight with high strength; high temperature and corrosion resistance. Folder on request.
484D Fibercast Corp.

Viscometers.....Catalog 0-57 describes fully the Brookfield synchroelectric viscometers, special models, accessories, and includes interesting highlights on viscosity as a valuable product dimension.
484E Brookfield Engineering Lab.

Pipe, Fittings, Valves

Conduit....."Therm-O-Tile" conduit for underground piping, its construction and installation is described in 12 p. publication. How the piping is supported, anchored and guided. Bulletin No. 9156.
484F Porter-Hayden Co.

Couplings, Hose.....LE-HI heavy duty high pressure hose couplings and their application to air, steam, gas, liquid and hydraulic lines are described and illustrated in 8 p. Bulletin No. 115.
484G Hose Accessories Co.

Fittings, Tube.....52 p. Catalog No. 4310 presents full line of "triple-lok" tube fittings in brass, steel, stainless steel and aluminum. All shapes including swivel nut and straight threaded with o-rings.
484H Parker Appliance Co.

*From advertisement, this issue

Any bulletin or catalog . . . yours for the asking

You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

Joints & Bellows.....Sola-Flex bellows & expansion joints are made in all sizes & varieties. They are durable, economical, & are based on advanced engineering designs. Request your copy of the latest Catalog.
120 *Solar Aircraft Co.

Joints & Couplings.....Good insurance against chemical piping casualties. Eliminate gaskets, adaptors, slip-joints; connect unlike piping ends and nozzles. Full details in Catalog No. AD-137.
353b *U. S. Gasket Co.

Joints, Expansion, Rubber.....Garlock rubber expansion joints are made from high-grade rubber, combined with plies of sturdy cotton duck and reinforced with steel rings. Full details in Folder AD-137.
223 *Garlock Packing Co.

Nozzles.....Describe company's line of nozzles for: oil atomizing; humidifying; air washing; desuperheating; spray ponds; milk powdering; acid chambers; concrete curing; etc. Catalogs 6-A and 6-C.
L471 *Monarch Mfg. Wks.

Nozzles.....A new nozzle with a pull-out-vane to simplify task of cleaning a spray nozzle mounted in hard-to-get-at places. Supplied in a range of sizes and capacities. "Full-jet Nozzle" Data sheet 7071.
485A Spraying Systems Co.

Nozzles, Spray.....Company makes available on request a completely detailed Catalog which provides valuable data on Spraco Nozzle line. Information on full cone, flat spray & hollow cone types.
326 *Spray Engrg. Co.

Nozzles, Spray.....Company provides a 48 p. industrial catalog with full data on thousands of standard and special nozzles—for every type of spraying. Also information on related equipment. Catalog No. 24.
T509 *Spraying Systems Co.

Pipe.....Request your free copy of this new pipe fabrication team bulletin, called "How Piping is Fabricated." Tells how Flori fabricates its pipe and how they sell this pipe as a team.
393 *Flori Pipe Co.

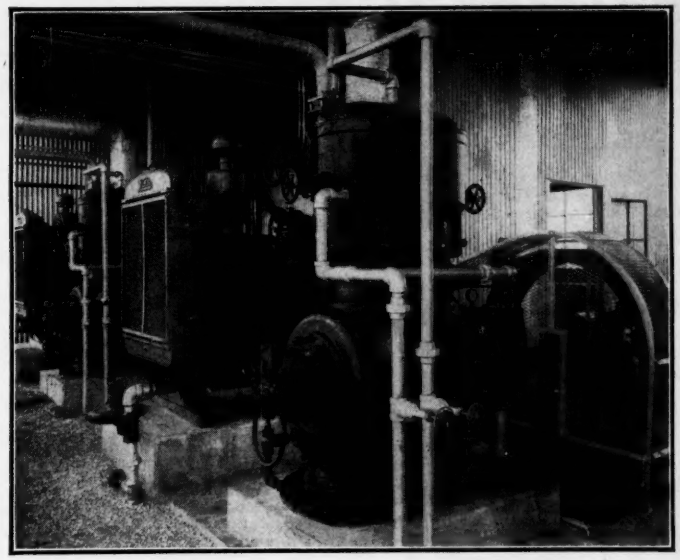
Pipe & Fittings, Tin-lined.....Developed to protect distilled water; a complete line of tin-lined pipe, fittings, line valves, faucets and accessories is offered. Ask for copy of Bulletin No. 139.
485B Barnstead Still & Demineral.

Pipe, Plastic.....Ace Rivivor is a new rigid threaded plastic pipe with good aging and high impact strength. Not affected by most inorganic acids and alkalis. Company offers full details in Bulletin CE-56.
320 *American Hard Rubber Co.

Pipe, Saran Lined.....Saran lined pipe, fittings and valves cut corrosion costs . . . can be cut in the field with available pipe fitter's tools. Liquid never touches metal in saran lined pipe. Request details.
215 *Saran Lined Pipe Co.

Pipe, Steam Traced.....Report savings of up to 30% in labor cost, plus important reductions in material and insulation costs. Information on applications and methods of using Unitrace in Bulletin AD418.
368 *Aluminum Co. of America.

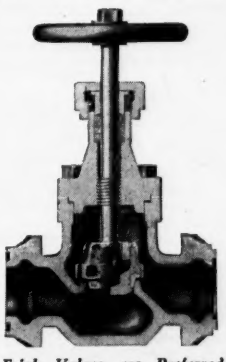
*From advertisement, this issue



How To Cool 5,000,000 cu. ft. of Natural gas most economically

Woodward & Company are doing it at their plant near Washington, Oklahoma, with two Frick refrigerating machines driven by natural gas engines of 90 horsepower. These Frick compressors, which handle ammonia, are of size 9″ by 9″, and run at 400 r.p.m

Propane and gasoline are recovered from the natural gas stream. A Frick condenser is used after the propane has been fractionated. The cooling equipment was installed by the Kay Engineering Company, Frick Distributors in Oklahoma City.



Frick Valves are Preferred for many high-pressure services: get catalog now.

Whether you need cooling equipment for air conditioning, process work, ice making, quick freezing or other refrigerating purposes, you get the utmost economy and reliability when you insist upon Frick equipment. Write today for literature and estimates on the cooling work you wish to do.

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WAYNESBORO, PENNA. U.S.A.

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Long Life Chempro Teflon Packings last for many months under corrosive conditions which destroy conventional packings in days... even hours. Replacement cost on the basis of service life cannot be compared.

Ideal for sealing pump and other rotating shafts against acids, caustics, aromatics, chlorinated hydrocarbons and other powerful corrosives. What's more, they give a *truly tight seal* with only slight gland pressure. Their low coefficient of friction makes lubrication unnecessary. See Bulletin CP 552.

3 types...

- TEFLON RING SETS
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*duPont Trademark

CHEMICAL & POWER PRODUCTS, Inc.

5 Broadway, New York 4, N. Y.

LITERATURE . . .

Pipe, Steel, Teflon Lined.....Wherever corrosion or electrical resistance is a factor, company is offering Teflon lined schedule 80 steel pipe in sizes of 1, 1½. 2 and 4 in. Request Bulletin T-100.
486A Haveg Industries.

Rings, Raschig, Porcelain.....Rings are smooth, completely vitrified, strictly non-porous and iron free. They are chemically inert to acids of all concentrations (except hydrofluoric). Bulletin.
197 *Lapp Insulator Co.

Tubing, Heat Exchanger & Condenser..... Electric-resistance-welded carbon steel heat exchanger and condenser tubing is widely used in the process industries, including petroleum refining, etc. Bulletin 412.
155 *Babcock & Wilcox Co.

Tubing & Pipe, Stainless Steel..... Strict adherence to chemistry requirements; full relief of cold work stresses; complete carbide dissolution; dimensional accuracy; etc. See product booklet.
406 *Damascus Tube Co.

Tubing, Teflon Thin-Walled.....Two-page bulletin, T-200, recommends use of this tubing wherever corrosion or electrical resistance is a factor. Bulletin charts diameters, wall thicknesses and tolerances, weights.
486B Haveg Industries.

Valves.....Duo-Bolt gates: sizes from ¼" to 4", screwed or flanged ends. Working pressures: 125 to 150 lbs. WSP, 200 to 225 lbs. cold WOG, non-shock. Complete details available in Form No. 1007.
373 *Ohio Injector Co.

Valves.....Company offers Stockham steel gate, globe, angle and check valves and Wedgeplug non-lubricated steel plug valves in carbon and special alloy steels. Details in Catalogs SV2 and W-1-56.
383 *Stockham Valves & Fittings.

Valves....."Greenwood specialty valves" for the oil and chemical industries—gate, check, quick-closing, sampling and drain—are illustrated and briefly described in Bulletin GV-21. Request your copy.
486C Vernon Tool Co.

Valves, Bronze.....Manufacturer's line of solder end and silver-braze end bronze valves in gate, globe and check designs for many varied applications are described in 4 p. folder. Bulletin DH-25.
486D American Chain & Cable Co.

Valves, Bronze & Steel.....Globe, angle, gate and other types detailed in new, 80 p. catalog on "Hancock" bronze and steel valves. Includes material specifications, flow charts and ratings.
486E Manning, Maxwell & Moore.

Valves, Butterfly.....Rubber lining of R-S butterfly valves protects entire valve body, gives you corrosion resistance with maximum economy. Complete line to meet your fluid control problems. Data.
479 *S. Morgan Smith Co.

Valves, Check.....Fast, quiet operation means low cost operation for check valves . . . and that's exactly what the Chapman Tilting Disc Check Valve is designed to do. Data in Catalog No. 30-A.
86 *Chapman Valve Mfg. Co.

* From advertisement, this issue

NATIONAL

HYDRO-FILTER

Unique turbulent area assures positive dust collection at constant efficiency . . . to the micron range

Here is the "heart" of the Hydro-Filter principle of dust separation. This violently turbulent area of water, bubbles and mist is produced by the countercurrent action of air against water. Constant long contact between the air being cleaned and the water which is doing the cleaning produces a scrubbing action which is positive, thorough and unaffected by variation in volume and velocity of flow. Dust is entrained by any, or all, of three means: (1) Entrapment within falling water droplets; (2) Impingement on bubble surfaces; (3) Impingement on wetted surface of glass spheres.

As the photo indicates, the entire collection area is continually flushed. There are no dead areas to corrode or erode. No moving parts to "load up" and reduce efficiency. Maintenance is a matter of *minutes a month.* Collection of dust to micron size is continuous and sludge removal automatic with the National Hydro-Filter.

Write for . . .

See why and how separating efficiencies of up to 98.9% on foundry shakeout dust are possible practical—and *continuous* with Hydro-Filter!

Bulletin 55

NATIONAL

Dust Collector Corp.

608 Machinery Hall Bldg., Chicago 6, Illinois

Subsidiary of National Engineering Company, Manufacturer of Simpson Mix-Mullers.

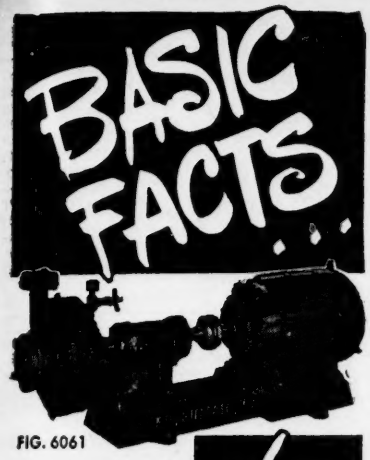

FIG. 6061

Fig. 19,488

for DECIDING ON TYPE OF PUMP; Write for TABER BULLETIN S-146

Practical GUIDE TO PUMP SELECTION

Big illustrations and brief descriptions with capacities and adaptability of pumps are contained in this unbiased compilation of facts to help avoid costly mis-application. Bulletin S-146.

TABER PUMP CO.
Est. 1859
294 Elm St.,
Buffalo 3,
N. Y.

K-777

TABER

LITERATURE . . .

Valves, Check.....Norwalk disc type check valves made for use in both horizontal and vertical positions. Designed to provide positive check against reverse flow of gas or air. Bulletins 1000M and 1300M.
487A Norwalk Valve Co.

Valves, Check.....Norwalk diaphragm type check valves, both horizontal and vertical, provide positive check against reverse flow of either gas or air. Rugged construction gives years of service. Bulletin 2000.
487B Norwalk Valve Co.

Valves, Check.....Norwalk diaphragm operated check valves prevent reversal of flow and accumulation of oxygen in gas carrying lines. Safely withstand back pressures up to 15 lbs. gauge pressure. Bul. 3000.
487C Norwalk Valve Co.

Valves, Control.....“Meter-Mo”, a pneumatic control valve, and “Little Richard”, a pneumatic on-off valve, fill need for trouble-free metering and control in high pressure installations. Cat. 406-C.
385a *American Instrument Co.

Valves, Drain or Sampling.....Jerguson Drain or Sampling Valve is completely self-draining, withstands severe conditions, and offers foolproof operation. Request details on Drain Valve No. 23.
R492 *Jerguson Gage & Valve Co.

Valves, Float.....No. 60 Float Valve—globe or angle—for many different services, simple in construction, accurate in operation. Has single seat, pilot stem. For information, see Bulletin 101B.
495b *Davis Regulator Co.

Valves, High Pressure..... Feature: Evalthrust ball-bearing yoke, internal streamlining, impactor handwheel, guided stellited disk, integral stellite seat, improved pressure-seal. Condensed Catalog.
402 *Edward Valves.

Valves, Needle.....The Marsh needle valve is now available in 416 stainless steel throughout. It is guaranteed for working pressure up to 10,000 psi. For complete details, request Bulletin No. NV-2.
T517 *Marsh Instrument Co.

Valves, Plug.....Engineered for maximum wear in valve-killing services. For any close-control steam service like drains, bypass lines, drips, blowoff, throttling, bleeders. Details in Folder 202-A.
411 *Jenkins Bros.

Valves, Regulating.....External pilot mounting provides simplified maintenance. Trouble shooting is faster, downtime is reduced. For information on wide range of regulating valves, see Bulletin 1005.
116 *Spence Engineering Co.

Valves Relief.....Relieve gas or liquid under pressure or vacuum and maintain constant pressure or vacuum on lines, holders and tanks. Relieves at predetermined pressure or vacuum. Bul. 6500.
487D Norwalk Valve Co.

Valves, Rubber Pinch.....For remote control of low rates of flow in small diameter piping. Sleeve sizes from 1/16 to ½ in. ID interchangeably use the same valve body. Request Bulletin M-1.
487E Red Jacket Co.

* From advertisement, this issue

You can save time, space, & labor

makes simple work of Filtering, Mixing, Storing

Regardless of the size or type of your installation, whatever your process may be, there's an Aslop Filter, Mixer, and Storage and Mixing Tank to “fit your job”. You can be sure of getting from Alsop the right unit properly applied—you can depend on Alsop proved performance features. Alsop Filters, Mixers, and Tanks are available in a complete range of sizes and capacities, and Alsop Equipment is custom fitted to your application by engineers who have thorough experience in Filtration and Agitation. For full information, recommendations and quotations write Alsop Engineering Corporation, 1202 White Road, Milldale, Connecticut.

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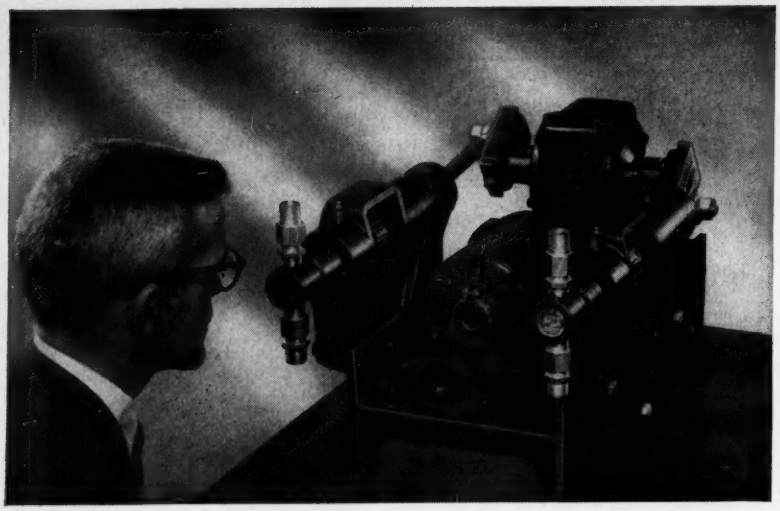

NEED ACCURATE CHEMICAL FEEDING TO PROCESS?

Check into this economical, efficient, proportioning pump by PROPORTIONEERS!

For greater accuracy, greater range . . . feed all chemicals (alkaline, neutral, or acid) with the Model 1140 Proportioneer. Pay less, get more . . . interchangeable measuring cylinders, super-accurate Vane-Guide check valves, percentage calibrated stroke-length scale, etc.

- **Accuracy—within ±1%**
- **Capacities—from 0.8 GPH to 900 GPH**
- **Adjustment range—15 to 1**
- **For discharge pressures up to 1340 psig**

MODEL 1140 PROPORTIONEER					
Discharge Pressures up to	MAXIMUM CAPACITY PER CYLINDER IN GPH* (Minimum feed rate 1/15th of max. cap. by stroke length adjustment)				
1340 psig.	10.7	13.3	17.8	21.3	26.6
670 psig.	20.9	26.1	34.8	41.8	52.2
335 psig.	42.7	53.3	71.1	85.3	106.5
168 psig.	83.6	104.4	139.2	167.1	209.0
84 psig.	171.0	213.0	284.5	342.0	426.0

*Five operating speeds available for various fluid viscosities. For capacities of DUPLEX MODELS (see photo), double the capacities shown in table. If you need capacities and pressures other than these, consult Proportioneers, Inc., manufacturer of the most complete line of proportioning pumps.

Free Bulletin

Request Bulletin No. 1140 for complete data. Write to PROPORTIONEERS, INC., 369 Harris Avenue, Providence 1, R. I.

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DIVISION OF
B-I-F INDUSTRIES
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B-I-F METERS FEEDERS CONTROLS

LITERATURE . . .

Valves, Solenoid.....Choose rugged industrial type Davis solenoid valves . . . for less downtime—less maintenance—more reliable control. For complete details of features, request copy of Bulletin 700.
495a *Davis Regulator Co.

Valves, Stainless Steel.....Cooper Alloy stainless steel valves feature: extra-deep stuffing box, union bonnet joint, retained renewable disc. See, "Design Factors in Stainless Steel Valves."
112 *Cooper Alloy Corp.

Valves, Steam.....Introduces single seat, internal pilot-operated, piston-actuated pressure reducing and regulating valve for steam service. Features built-in strainers. Described in Bulletin 981.
488A A. W. Cash Co.

Valves, Steam Pressure.....Bulletin 981 on Type 44 pilot-operated, pressure-reducing and regulating valve includes photo and cross-sectional diagram, specifications, ratings, capacity chart, instructions.
488B A. W. Cash Co.

Valves, Steam Solenoid.....Two way packless valve for variety of applications in automatic control of steam and hot fluids or gases at up to 400 F. Forged brass body and bonnet. Bull. 8222A, Form V5032.
488C Automatic Switch Co.

Process Equipment

Autoclaves.....Details of glassed carbon steel autoclave which handles reactions up to 750 psi. are given in Bulletin 939. Variable-speed agitation and 1-, 2-, and 3-gal. capacities.
488D Pfaudler Co.

Blenders.....Pilot plant blending to largest production runs are handled by standard models of Sturtevant blenders with capacities from 10 cu. ft. to 900 cu. ft. Full details in Bulletin No. 080B.
227 *Sturtevant Mill Co.

Blenders, Twin Shell.....Standard model Twin Shell for gentle mixing action. "Intensifier" for difficult-to-blend materials, "Liquid-Solids" blender for blending liquids into dry materials. See Catalog 14.
140 *Patterson-Kelley Co.

* From advertisement, this issue

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Standard Adapter
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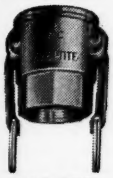
Your best buy is

EVER-TITE
-the best quality
QUICK COUPLINGS

You save *time* and *money* when you use Ever-Tite Couplings because they speed-up deliveries, prevent leakage, and save wear on equipment.

Tightness is predetermined in manufacture by positive gasket compression. There are no sliding rings—no springs, ball bearings, snaps or lugs to fit. You just slip the coupler over the adapter, and close the handles.

If you want to get the *most* in coupling value get *Ever-Tite*. The Ever-Tite Trademark is a hallmark of dependability in fittings for the petroleum industry—proved by 18 years of pre-eminence. Ask your distributor now.



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Dust Cap

EVER-TITE Dust Protectors

Every EVER-TITE saves time and money

Ozone BY WELSBACH

...an economical answer to chloride corrosion problems

Ozone now plays an important part in a new fractional distillation technique for the recovery of nitric acid following atomic fuel extraction.

During distillation, a side stream of the extraction raffinate is sparged with a one percent concentration of ozone in air. Chlorides are oxidized by ozone to free the chlorine which is desorbed and removed by the sparge air, resulting in marked improvement in the concentrator performance and elimination of costly corrosion.*

Versatile in its applications and low in cost, Welsbach ozone is finding more and more applications in industry. It is used, for example, as an oxidant in the manufacture of cortisone . . . and its specificity and purity makes it valuable in other chemical syntheses reactions.

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Write for this booklet on Welsbach Ozone Generation for Industrial Application.

* Based on a paper by D.S. Arnold, A. Whitman and F.J. Podlipec published in Chemical Engineering Progress, Sept., 1956

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Impervite RUPTURE DISK

Accurate to ±5% of Rated Burst... Burst characteristics independent of temperature changes... Studies to date indicate No Fatigue Failure... Can be used at 75% of Rated Burst... Operational Temperatures to 650°F. permitted... Unaffected by action of practically all corrosives, except a few strong oxidizing agents.

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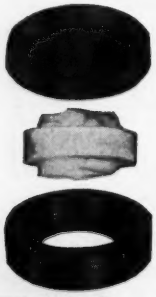

HIGH TEMPERATURE DISK

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• IMPERVITE impervious graphite Rupture Disks are a new idea in frangibles. In addition to their other advantages, they provide almost 100% breakout of pressure membrane to allow full vent opening for safe escape of excess pressure . . . And because IMPERVITE Rupture Disks can be used at 75% of rated burst, they reduce the required differential between pressure vessel design and rupture disk burst pressure. Also, IMPERVITE Rupture Disks permit a smaller and less expensive inventory.

IMPERVITE Rupture Disks are available for use with gas or liquid. They are furnished in diameters from 2" to 24" for pressures from full vacuum to 250 psi at temperatures to 650°F., with a tolerance of ±5% of rated burst.

Get full information now, for simpler, more dependable, lower cost protection of your pressured systems. Ask for Catalog No. 315.

... an exclusive development of Falls Industries

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31915 AURORA ROAD • SOLON, OHIO

LITERATURE . . .

Cement Machinery.....“Nordberg Machinery for the Cement Industry,” 9-page catalog, covers this machinery: crushing, screening, grinding, pyro-processing and power generation. Request your copy.
490A Nordberg Mfg. Co.

Centrifugals.....Batch-Master offers choice of perforate and imperforate baskets . . . corrosion-resistant materials . . . manual unloader if desired. Further information available in Bulletin TC-14-56.
462 *Tolhurst Centrifugals.

Centrifuges.....Merco pressure centrifuge, new unit for continuous centrifugal separations under pressure conditions. Accomplishes concentration, washing, soluble recovery, classification. Bulletin 2600.
490B Dorr-Oliver.

Centrifuges, Pressure.....In new Bulletin 2600, Dorr-Oliver sets forth outstanding features, design principles, operation, advantages, sizes and capacities of first commercial high-pressure centrifuge.
490C Dorr-Oliver.

Chlorine Cell.....Chlorine for water purification is produced by the new Hering electrolytic chlorine plant according to new descriptive 4-page bulletin. Capacities from 100 g./hr. to 1 kg./hr.
490D Epic, Inc.

Combustion Equipment.....If you have process heating problems, Eclipse will design combustion assemblies to meet your special requirements. See catalog describing burners, blowers, mixers and valves.
339 *Eclipse Fuel Engrg. Co.

Comminutors.....New brochure covers complete line of impact-in-air comminutors. Design variations of these continuous units reduce wet or dry solids, spray-blend wet and dry materials.
490E Motiograph, Inc.

Crushers.....In most Allis-Chalmers gyratory crushers, size adjustment, compensation for wear, emergency unloading are accomplished by the flick of a switch. Specific product bulletin.
46-7c *Allis-Chalmers Mfg. Co.

Crushers.....Line of reduction equipment that includes crushers, roll mills, granulators, and chippers is covered in leaflet that lists outstanding characteristics of each type of equipment.
490F Franklin P. Miller & Son.

Crushers, Cone.....Symons Cone Crushers offer greater productivity through more efficient reduction crushing: unequalled output, selective crushing, low operating costs. Full details in Bulletin 247.
490G Nordberg Mfg. Co.

Crushers, Laboratory.....Bulletin 1677 describes laboratory crushers used for crushing samples and making pilot runs on a wide variety of materials. Capacities 600-2,000 lb. per hr. Typical installations.
490H American Pulverizer Co.

Disks, Rupture.....Impervite rupture disks are standard for 150# flanges, temperature to 300°F., 5% accuracy, diameters from 2" to 12". New idea in fragibles from Falls. Request Catalog No. 315.
490 *Falls Industries.

* From advertisement, this issue

Dry Blenders & Ribbon Mixers..... Ribbon mixers are so designed that any proportion of various materials can be thoroughly mixed. Conical dry blenders are the standard of lower blending costs. Bul. 78.
369e *International Engineering.

Dryers.....Modern dryers of the flash, spray, tubular and drum type have been built for more than 300 plants according to recent bulletin from German manufacturer of this equipment.
491A Karl Fischer.

Dryers.....Help solve problems of drying air or other gases. Offer advantages; simplicity of operation and maintenance; low installation cost and minimum maintenance expense. Bulletin D-27.
129 *C. M. Kemp Mfg. Co.

Dryers.....Lectrodryers can dry air and gases in volume to dewpoints below —100°F—can drop relative humidity lower than 10%. "Because Moisture Isn't Pink" describes drying installations in industries.
376 *Pittsburgh Lectrodryer Co.

Dryers.....Full line pressure reactivation, purging eliminated, longer absorpbent life, no moving parts, simple design, all air or gas entering dried without loss. Complete details in Bulletin 16.0.081.
360 *J. F. Pritchard & Co.

Dryers, Rotary.....The Davenport rotary hot air dryer is of stainless steel construction. Dryer is installed in one of the large processing plants, drying wheat gluten. For complete details, request Catalog "A."
T518 *Davenport Mach. & Fndry.

Dryers, Spray.....Bulletin tells how Swenson soluble coffee spray dryers are specifically designed for the production of "flavor-laden" soluble coffee. Full details available in Bulletin SW-400.
52-3g *Swenson Evaporator Co.

Dust Collectors.....Efficiency of Type W Roto-Clone dust collector results from unique design, which combines scrubbing action of liquid sprays and principle of dynamic precipitation. Bul. 274.
98 *American Air Filter Co.

Dust Collectors.....Separating efficiencies of up to 98.9% on foundry shakeout dust are possible, practical and continuous with the Hydro-Filter. Turbulent area assures positive dust collection. Bulletin 55.
R486 *Dust Collector Corp.

Dust Collectors.....Pangborn collectors trap dust at the source, clean so thoroughly that in the winter many firms cut heating costs by recirculating the already-heated, cleaned air. Bulletin 922.
357 *Pangborn Corp.

Dust Collectors.....In almost every type of industry . . . users have found high efficiency, simplicity & economy of Dustube collectors a difficult combination to equal for top performance. Bulletin No. 372C.
78 *Wheelabrator Corp.

*From advertisement, this issue

KILL FOAM THE EASY WAY...

New G-E silicone Anti-Foam 60 disperses easily—pays for itself

CONVENTIONAL ANTI-FOAM

Conventional high-viscosity silicone anti-foam agents (above) do not disperse readily in water—require vigorous stirring.

NEW G-E ANTI-FOAM 60

Low-viscosity G-E ANTI-FOAM 60, however, can be *poured*—and disperses instantly!

Costly, troublesome foaming can now be controlled—more easily—with General Electric's new silicone ANTI-FOAM 60. Easy to disperse, this low-viscosity silicone emulsion can be used as supplied, or reduced with water to any desired concentration. *Little or no stirring* is required.

PAYS FOR ITSELF

You'll find ANTI-FOAM 60 pays for itself by the way it reduces processing time, eliminates costly boil-overs, increases kettle capacity. Incredibly small amounts are needed, for example: **50 PPM in paper-making operations**
3 PPM in textile sizing solution
10 PPM in latex

FREE SAMPLE!

SILICONE PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
Section 860-1B, Waterford, N. Y.

Please send me a free sample of G.E.'s new silicone ANTI-FOAM 60.

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Firm_____
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GENERAL ELECTRIC

Equipment...material...metallic or non-metallic...flat, curved... revolving or stationary—you can read its surface temperature accurately in less than 3 seconds!

Compact in size, complete in precision design and workmanship, this rugged instrument assures the highest standards of speed, accuracy and dependability. Heavy-duty, shock-resisting movement is housed in a balanced unit that is easy to handle...reaches any point.

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 559, 420 N. LaSalle St., Chicago 10, Illinois.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

LITERATURE . . .

Eliminators, Mist.....How to solve many liquid entrainment problems in scrubbers, absorbers, evaporators, knockout drums, cracking towers is explained in new 16-page Schuylernit manual.
491B Schuyler Mfg. Co.

Filtration Unit.....Removes minute physical impurities from water down to 1/10th micron at the rate of 3 to 10 gal./min. Details, operation and specifications in Technical Bulletin R-142.
492A Heico, Inc.

Filters, Backwash.....Clean filters by operating a few valves . . . no time consuming or dangerous manual disassembly and cleaning necessary. If you have a chemical filtration problem, see Bulletin 431.
481 *R. P. Adams Co.

Filters, Flow.....Nugent full flow filters will remove foreign solids as small as 2 microns from lube or fuel oil before they can reach and damage vital precision parts. Full details in descriptive literature.
361 *Wm. W. Nugent & Co.

Filters, Gas.....Norwalk gas filter completely removes all fine dust and scale from the gas as it passes through the filter. Reduces service calls and pilot light outages. Complete details in Bulletin 9200.
492B Norwalk Valve Co.

Filters, Horizontal Plate . . . . . New "Batch-Miser" horizontal plate filter recovers 100% of both liquid and solids—without scavenging. There is no leakage, no warping of plates. Request Bulletin.
463 Niagara Filter Div.

Filters, Horizontal Pressure.....Details in these filters found in Publication 6322 include operation, control, filter-bed materials, design features, accessories and drawings of arrangements.
492C Cochrane Corp.

Filters, Horizontal Pressure.....Filters with many convenience features: quick opening door, shakers for cleaning, equal size leaves. Can be automated for continuous operation. Request Bulletin NH-122.
6-7c *Industrial Filter & Pump.

Filters, Liquid.....All-metal filters for full flow filtration of lubricating, hydraulic and fuel oils. Of special screen disc construction, sizes are from 1.7 to 720 gpm. capacities. LFC Catalog.
492D Air-Maze Corp.

Filters, Liquid.....Company offers 12 pg. bulletin describing its Staynew filter. Contains engineering & performance data, photos, descriptions of filtering media, recommended use of each, etc. Bulletin 330.
118 *Dollinger Corp.

Filters-Mixers-Tanks.....Alsop filters, mixers, and tanks are available in a complete range of sizes and capacities, and the equipment is custom fitted to your application. Details in new complete catalog.
R487 *Alsop Engrg. Corp.

Filters, Tubular.....Excellent for polishing, as a trap filter or scavenger. Operation and cleaning is greatly simplified by inside-out flow system. For complete details, request Bulletin TS-160.
6-7d *Industrial Filter & Pump.

* From advertisement this issue

The new Jerguson No. 23 Drain or Sampling Valve is completely self draining, for the valve stem seats on the outside of the valve body. It is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent the typical condition of liquid remaining in the nipple and valve inlet.

This rugged, new Jerguson Valve has outside screw and yoke construction to meet high temperature or corrosive conditions where inside threads cannot be tolerated. The efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times. The No. 23 Valve provides foolproof operation because the stem is constructed with a left-hand thread, thus allowing the valve handle to operate in the normal direction of standard valves.

Available in sizes from ¾" to 2" N.P.T. ¾" and 1" sizes are recommended for pressures of 4000 lbs. @ 100° F. and 1000 lbs. @ 750° F.; 1¼, 1½ and 2" sizes are recommended for 600 lbs. @ 100° F. and 250 lbs. @ 750° F. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

Write for data unit and complete details.

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Gages and Valves for the Observation of Liquids and Levels

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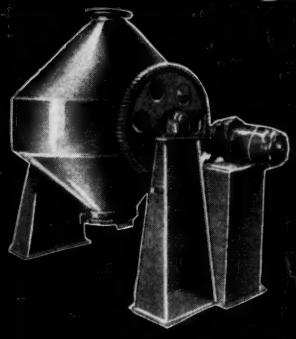
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

Devine
PROCESS EQUIPMENT
for
blending



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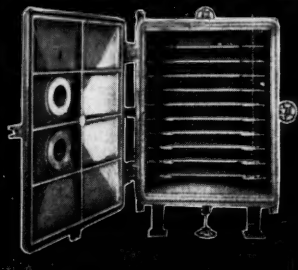
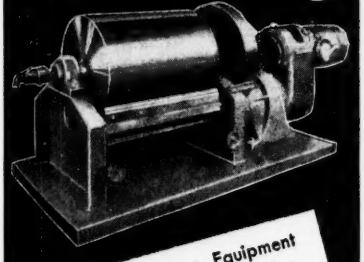


... flaking



Use Devine Process Equipment from pilot plant through production phase. The Devine laboratory is available for testing processes and sizing equipment. Your inquiries are invited.

C-2

J. P. DEVINE MFG. CO.
49th Street and A.V.R.R.
Pittsburgh 1, Pa.

LITERATURE . . .

Filters, Vertical.....New built-to-order vertical filters solve complex problems & are easily adapted for special uses. Details on flow systems, special equipment, filter & leaf construction in Bulletin 111.
6-7b *Industrial Filter & Pump.

Filtration Equipment . . . . . Sperry makes available a catalog complete with charts, tables, and diagrams to help in the operation, maintenance and selection of filtration equipment. See Filtration Catalog.
R493 *D. R. Sperry & Co.

Flocculation Equipment.....Company offers complete line of equipment for economical handling of bulk or packaged chemicals—bucket elevators, tray elevators, screw conveyors and feeders, etc. Book 2442.
493A Link-Belt Co.

Homogenizers & Dispersers.....Homogenizers work at high pressures, by means of tremendous velocity and energy gradients. Sub-Micron disperser handles pigments-abrasive dispersions. Buls. H-55, SMD-55.
174-5a *Manton-Gaulin Mfg. Co.

Homogenizers, Laboratory.....Laboratory homogenizers are available on rental basis. Machines for exploring new Gaulin dimension of particle control for improved mixing or blending. Bulletin LH-55.
174-5b *Manton-Gaulin Mfg. Co.

Mills, Ball & Pebble.....Of welded steel construction, and furnished in all standard sizes from 18" x 24" to 96" x 144" inclusive, with 9 different drive arrangements. For details, see Bulletins 100-A, 100-B.
369e *International Engineering.

Mills, Colloid.....RE colloid mill is a highly advanced, two-stage design which provides continuous micrometer control for producing superior emulsions or dispersions. Details in Bulletin C-56.
174-5c *Manton-Gaulin Mfg. Co.

Mills, Grinding . . . . . Allis-Chalmers can meet your specifications whether your process calls for individual mills or a grouped stage grinding series. Request details on 7 different types of grinding mills.
46-7b *Allis-Chalmers Mfg. Co.

Mills, Grinding.....Nordberg grinding mills for efficient, low cost processing of cement, ores, industrial minerals and rock products. Offer these types: rod, ball, tube and pebble, compartment. Bulletin 232.
493B Nordberg Mfg. Co.

Mixers.....If you have a process entailing critical operating conditions, request information on durable Eastern Mixers. Offers engineering assistance in selection of proper mixers. Request catalog series 1.
379a *Eastern Industries.

Mixers.....Company makes available Confidential Mixing Data Sheet. Helpful checklist enables you to develop a complete technical description of agitation required for your process. Bulletin B-107.
283d *Mixing Equipment Co.

* From advertisement, this issue

Got a Production Bottleneck?

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— all sizes, all types for all requirements. Available with center, side or corner feed; open or closed delivery; simple or thorough washing; jacketed plates for filtering at high or low controlled temperatures.

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Please send me a free copy of the Sperry Filtration Catalog.

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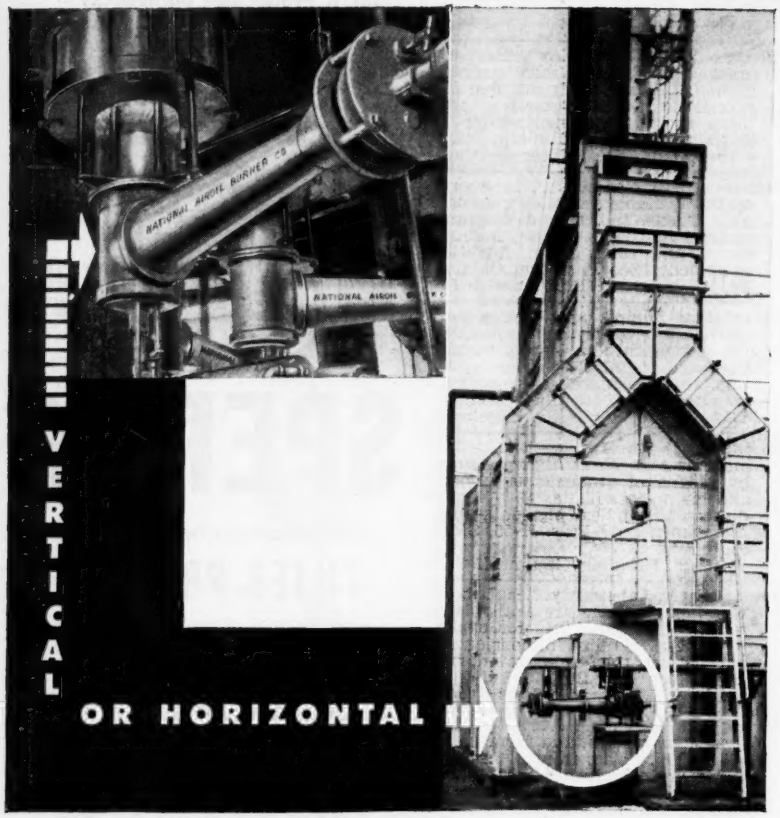

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OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNIT'S clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

LITERATURE . . .

Mixers, Angular.....Diamond-shaped agitator of the Troy angular mixer provides three-dimensional kneading, shearing, mixing action that breaks up agglomerates. Full details in Bulletin No. GP56.
T515 !Troy Engine & Machine.

Mixers, Clay.....Day mixers are ruggedly built, precisely engineered, for 24 hour operation. Available in in 5, 200, 350, 550, 660, 1000 gal. pasting capacities. Details are available in Data Sheet I-300 CM.
350 *J. H. Day Co.

Mixers, Horizontal Batch.....Horizontal Batch Mixer, Style "B", is ideal for rapid, intimate mixing of small percentages of a number of critical ingredients with large bulk of basic material or filler. Bul. 95.
89 *Sprout-Waldron.

Mixers, Laboratory.....You get as much as 20 years' service from a Lightnin Laboratory Mixer. Can run Model F at any speed up to 1600 RPM. Four other models to choose from. Details in Bulletin B-112.
283h *Mixing Equipment Co.

Mixers, Liquid.....Shear-Flow industrial mixers are discussed in a new brochure which illustrates the size range, applications, specifications and exclusive features of this new type unit.
494A Gabb Special Products.

Mixers, Portable.....Use in industry reduces costs, saves time, labor and secures better and more refined products. Catalog includes data on construction, dimensions, specifications, etc. Bulletin B-108.
283e *Mixing Equipment Co.

Mixers, Side Entering.....Company can furnish either standard packed stuffing box or mechanical seals. On most standard types either seal can readily be converted to the other, as desired. Bulletin 72-B.
369b *International Engineering.

Mixers, Side Entering.....Furnishes detailed information on features, typical applications, mechanical design, maintenance, shaft seals, methods of installation, etc., in Catalog B-104.
283c *Mixing Equipment Co.

Mixers, Top Entering.....Illustrated 32 p. Catalog includes advantages, typical installations, mechanical description, construction information, dimensions and selection tables, etc. Catalog B-102.
283a *Mixing Equipment Co.

Mixers, Top Entering.....Makes available pertinent information on top-entering mixers (propeller type) . . . for closed tanks, pressure & vacuum . . . for open & loose-covered tanks. Catalog B-103.
283b *Mixing Equipment Co.

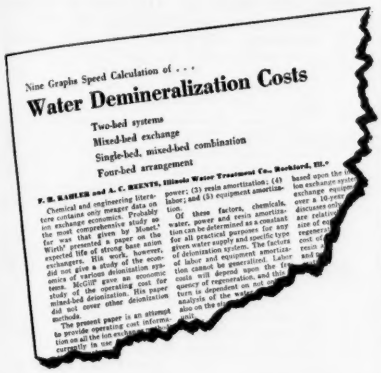
Mullers.....If you mix dry or semi-solid materials, "Mulling in the Chemical & Process Industries" will show you why and how Simpson Mulling can do a better, faster and truly more thorough blending job.
93 *Simpson Mix-Muller Div.

Mullers.....Specifications, application data and general arrangement drawings of the 3-cu.-ft. capacity portable Mix-Muller are found in new Porto-Muller bulletin now available on request.
494B Simpson Mix-Muller Div.

* From advertisement, this issue

ILLCO-WAY ionXchange

HOW MUCH DOES IT COST?


Nine Graphs Speed Calculation of . . .

Water Demineralization Costs

Two-bed systems
Mixed-bed exchange
Single-bed, mixed-bed combination
Four-bed arrangement

F. B. BARLER and A. C. BEENTS, Illinois Water Treatment Co., Rockford, Ill.

Chemical and engineering literature contains only meager data on ion exchange economics. Probably the most comprehensive study so far was that given by Mantell. Wirth[1] presented a paper on the expected life of strong base anion exchangers. His work, however, did not give a study of the economics of various deionization systems. McGriff[2] gave an economic study of the operating cost for mixed-bed deionization. His paper did not cover other deionization methods.

The present paper is an attempt to provide operating cost information on all the ion exchange systems currently in use. The information is based upon the ion exchange equipment manufactured by the Illinois Water Treatment Co. over a 10 year period. The paper discusses only those factors which are relative to the selection and size of equipment for a given service. Operating cost information is presented for the following systems:

(1) Two-bed systems
(2) Mixed-bed exchange
(3) Single-bed, mixed-bed combination
(4) Four-bed arrangement

The operating cost for any of these systems is dependent on the following factors: (1) chemicals, (2) water, (3) power, (4) resin amortization, and (5) labor; and (6) equipment amortization.

Of these factors, chemicals, water, power and resin amortization can be determined as a constant for all practical purposes for any given water supply and specific type of deionization system. The factors of labor and equipment amortization cannot be generalized. Labor costs will depend upon the frequency of regeneration, and this in turn is dependent on not only the analysis of the water supply but also on the [illegible]

READ THIS ARTICLE!

Experienced ILLCO-WAY engineers compiled the figures for this authoritative report from years of pioneering experience. Nine easily-read charts cover practically every possible combination of water impurities and contemplated systems of treatment. Costs are shown directly in cents per thousand gallons. With the versatility of this presentation, it is easy to work back and forth over the various choices, to determine quickly that which would be most acceptable for the given conditions. This article appears on pages 206-210 in the January, 1957, issue of CHEMICAL ENGINEERING. We have reprints available and will be very glad to furnish them on request.

ionXchange

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NEW YORK OFFICE: 141 E. 44TH ST., NEW YORK 17, N.Y.
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Published – SEPTEMBER 15th

Chemical Engineering's 1957 Annual Inventory Issue

A McGraw-Hill Publication, 330 West 42nd St., New York 36

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VALVE SPECIALTIES FOR STEAM, AIR OR GAS

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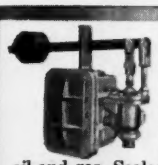

SOLENOID VALVE
Heavy duty, durable valve that will handle the toughest jobs. For viscous fluids, resins, syrups, varnishes as well as steam, water, oil and gas. Sealed, self-cleaning, explosion proof, renewable disc, visible action, emergency manual operation. ¼" to 12", 300 psi. A.C. or D.C.
Send for Bulletin 700.

No. 60 FLOAT VALVE GLOBE OR ANGLE

A valve for many different services, simple in construction, accurate in operation. Single seat, pilot stem. Tight closing, no water hammer, non-sticking. No internal packing. Sizes ½" to 12". Brass or semi-steel bodies, pressures to 125 lbs. hydraulic.
Send for Bulletin 101B.

No. 164D PACKLESS FLOAT BOX

For handling volatile or flammable fluids. Leakproof, packless, thanks to Davis Dia-Ball unit (see below). Sealed, flexible joint, minimum maintenance, higher sensitivity, less friction. Operates control valves from ½" to 8". Float sizes—6", 8" or 10". Pressures to 250 psi. Temperatures to 300° F. **Write for Bulletin.**

DAVIS DIA-BALL TRANSMISSION UNIT
Packless diaphragm ball transmission arm for Davis level controls, float boxes and lever units. Patented, leakproof construction. Eliminates friction, accurate transmission, minimizes maintenance due to packing, less hazardous for flammable fluids because of leakproof feature.
Write for details.

SEND FOR COMPLETE FILE OF LITERATURE

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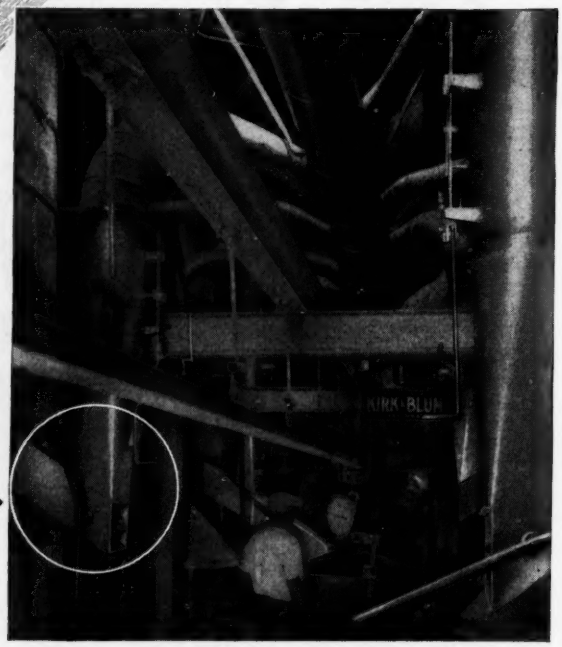
KIRK & BLUM

DUST CONTROL SYSTEM

saves power through automatic orifice selection



Top portion of each chute serves as dust control inlet orifice. Dust is removed before it can reach batch area.

Each individual dust collection port is designed to be automatically opened by monorail batch car when it stops at particular silo. Closes automatically when car leaves.

COMPANY: The Chas. Taylor Sons, Co., Cincinnati, O., a Subsidiary of National Lead Co., manufacturers of special refractories.

PROBLEM: Dust collecting system for batch mixing area containing 7 silos of refractory grain which feed by chute into monorail batch car as it passes down line.

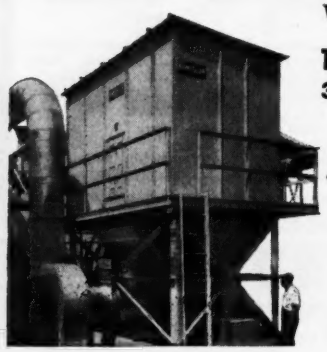
SOLUTION: Kirk & Blum system assures just the right balance to remove light dust without stealing usable product.

Ingenious damper arrangement conserves air, assures highest system efficiency. **No silo dust collection port is open except when its chute is operating.**

Let Kirk & Blum — with 50 years experience — solve your intricate dust collection problems.

Write today for detailed information.

THE KIRK & BLUM MFG. CO.
3208 Forrer St., Cincinnati 9, Ohio



10,000 C.F.M. dust arrestor located outside saves space. Collected dust moves to central disposal point by screw conveyor.

LITERATURE . . .

Pelletizers, Plastic.....How Taylor-Stiles 700 Series multiple-knife cutters reduce extruded plastic rods to pellets is shown in new 4-page folder. Unit cuts 10 tons of uniform pellets per hr.
496A Taylor-Stiles & Co.

Presses, Filter.....Offer numerous features: lowest cost per sq. ft. of filtering area; produces perfect clarity of filtrate; can be used in decolorizing — deodorizing; etc. "Guide to Better Filtration."
465a *T. Shriver & Co.

Process Equipment.....32 p. bulletin covers all Allis-Chalmers equipment for the process industries. This bulletin, as well as literature covering specific equipment lines, is available. Bulletin 25C6177.
46-7a *Allis-Chalmers Mfg. Co.

Reclaimer Systems, Oil.....A simple economical and efficient method of restoring contaminated lubricating and sealing oil to the full value of new oil. Offers details on reclaimers in Bulletin R-160.
325 *Hilliard Corp.

Screens, Vibrating.....Allis-Chalmers vibrating screens are built in single and multiple-deck models for use in scalping, wet or dry sizing, washing, rinsing, dewatering, and media recovery. Details.
46-7d *Allis-Chalmers Mfg. Co.

Screens, Vibrating.....“Symons” Type F horizontal vibrating screens—screening action controls flow of material, accurate sizing, require minimum headroom, range of deck combinations. Bulletin 248.
496B Nordberg Mfg. Co.

Separators, Electro Dynamic.....High tension or electro dynamic separators described in Bulletin HTB-103 are compared with electrostatic separators. Covers Lab. and industrial units, minerals handled.
496C Carpco Mfg.

Wire Cloth & Screen.....In order to improve your filtering, straining, sizing operations, specify Ludlow-Saylor wire cloth & screen. Complete details in Condensed Screen Reference Catalog.
332 *Ludlow-Saylor Wire Cloth.

Pumps, Blowers, Compressors

Compressors.....Describes Allis-Chalmers single and two-stage vane type compressors for shop air, gas handling, drilling and numerous other applications. Bulletin Nos. 16B8244 and 16B8126.
75 *Allis-Chalmers Mfg. Co.

Compressors.....Features: completely enclosed main frame with removable, bolted cover plates; gasketed covers keep oil in—dirt out; two crankshaft counterweights for better balance. Buls. HAC-36, HAC-40.
370 *Gardner-Denver Co.

Compressors.....Every Norwalk compressor is test-run for 8 hours, then taken down for inspection before shipment. Complete catalog describes compressors from single to six stages.
343 *Norwalk Co.

* From advertisement this issue

Compressors, Centrifugal.....De Laval compressors are designed and built for heavy duty continuous operation. Rugged, horizontally split casings . . . individually designed impellers . . . etc. See Bulletin 0504.
219 *De Laval Steam Turbine Co.

Compressors, Rotary.....Fuller applies each compressor to a specific job, with resultant overall plant economy, as well as power savings. Details on rotary compressors available in Bulletin C-5A.
427 *Fuller Co.

Fans, Centrifugal.....40 p. booklet features new listing of quiet operating, large capacity, slow speed centrifugal fans. Presents detailed performance charts. Details in Bulletin C-103, Supplement No. 1.
497A Chicago Blower Corp.

Fans, Industrial.....Stainless Steel General Industrial Fan resists injurious fumes while operating at top efficiency at temperatures up to 800°F. Details made available in Bulletin No. 521.
115 *New York Blower Co.

Pumps ..... Available in aluminum, bronze, stainless steel, Hastelloy and titanium, Aldrich fluid ends handle all types of liquids—nitric acid, caustic solutions, fatty acids, etc. Details in Data Sheet 100.
88 *Aldrich Pump Co.

Pumps.....Bulletin details the distinctive characteristics, materials of construction, types, sizes and capacities of the six major types of Dorr-Oliver pumps for the chemical process industry. Bulletin 5000.
497B Dorr-Oliver.

Pumps.....Company offers two types of pumps for volume pumping and for great pressure . . . single-stage and double-stage. Bulletins 721.6 and 720.4 for single-stage pumps, Bulletin 722.6 for double-stage pumps.
473 *Goulds Pumps.

Pumps.....For information on Triplex Hi-Pressure Pumps request Bulletin P-55. Details on Hinckley Rotary Positive Displacement Pumps in Bulletin HR-57. Gaulin HX Pumps covered in Bulletin HPX-55.
174-5d *Manton-Gaulin Mfg. Co.

Pumps.....Are built for abusive applications only—abrasion, corrosion, heat, heavily loaded liquids, trash. Complete range of sizes—horizontal and vertical shafts. Full details in Catalog No. 5206.
L501 *Nagle Pumps.

Pumps.....Practical Guide to Pump Selection—illustrations & descriptions with capacities & adaptability of pumps contained in compilation of facts to help avoid costly misapplication. Bulletin S-146.
L487 *Taber Pump Co.

* From advertisement this issue

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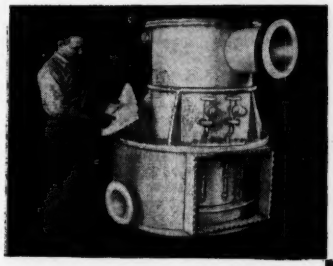
Corrosion Resistant And Non-Contaminating Plastic Fabrications

- Chemically inert
- Strong — light in weight
- Assure dependable, longer trouble-free operation
- Impact resistant
- Reduce installation and maintenance costs
- Impervious to acids and alkali
- Electrically non-conductive
- Economical



Fabricated and welded of AGILENE this fume scrubber has been installed at an atomic energy plant. Entirely impervious to attack by hydrofluoric acid solutions and fluorides up to 170°F., the scrubber is 4′ in diameter and 5′ high. The entire system is corrosion proof with AGILENE ducting and valves handling a gas flow of 2500 cfm at 1½ psi.

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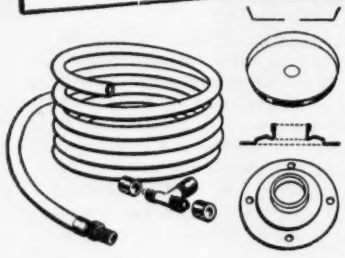

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LITERATURE . . .

Pumps.....If you have a problem where metering, blending or other accurate pumping of liquids is concerned let Viking help solve it. Use Viking pumps for accurate pumping. For information, Bulletin 57Sc.
T513 *Viking Pump Co.

Pumps, Acid.....80-gpm. centrifugal pump with hard rubber casing and impeller, Hastelloy C shaft. Handles nearly all corrosives. Mechanically simple, trouble-free. For details, request Bulletin CE-55.
321d *American Hard Rubber Co.

Pumps, Acid.....Bulletin describes the design features, corrosion-resistant materials of construction, applications, sizes and capacities of the Olivite acid handling pump. Full details in Bulletin No. 5004.
498A Dorr-Oliver.

Pumps, Boiler Feed.....Type RR two-stage and four-stage pumps have efficient, balanced impellers, oversize bearings and shafts, rugged casings with simply formed water passages. See Bulletin 980.
92 *Buffalo Pumps.

Pumps & Boosters.....Catalog 1957 on rotary positive air and vaccum pumps, gas boosters and air motors details construction, dimensions, capacities, new performance curves and installations.
498B Leiman Bros.

Pumps, Centrifugal . . . . . Illustrated reference describes line of SSV centrifugal pumps. Includes details of construction of the various sizes available, operating advantages for users, etc. Bulletin No. 107.
R498 *Frederick Iron & Steel.

Pumps, Centrifugal.....Morris pump operates with minimum attention . . . lowers maintenance costs . . . can be quickly dismantled for inspection . . . avoids lengthly lay-up time. Full details in Bulletin 185.
470 *Morris Machine Works.

Pumps, Centrifugal.....Choice of mechanical seals—or packing—with Standard End Suction Centrifugal pumps. Easily convert from one to the other using standard stock parts. Bulletin W-300-B4B.
44-5 *Worthington Corp.

Pumps, Close-Coupled Centrifugal..... Type GSC pumps are standard centrifugal pumps that handle a wide range of general applications. Circular 191 gives details and complete range of sizes.
498C Dean Bros. Pumps.

Pumps, Fluid Power.....Type HG fluid power pumps for continuous pressure, constant displacement, heavy duty service are discussed in new 4-page bulletin 46601-B now available from the manufacturer.
498D Oilgear Co.

Pumps, Metering.....Sup. Bulletin 1105-3 describes the unique features of a low-capacity, medium-pressure proportioning pump. Included are capacity table and cut-away dimension drawings.
498E Proportioneers, Inc.

Pumps, Oil Diffusion.....New 1-in. water-cooled oil diffusion pump produces high vacuum operating pressures economically at 15 liter per sec. rate. Brief description and installation instructions.
498F Arthur F. Smith Co.

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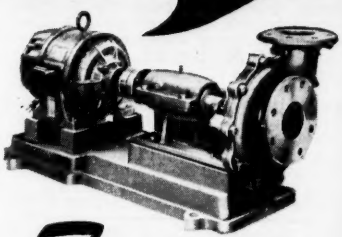

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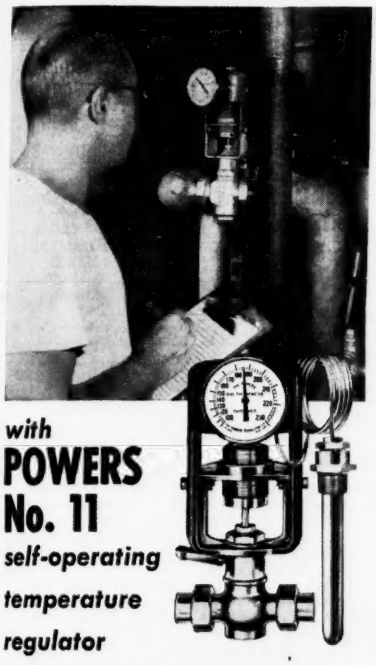

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The Powers Regulator Co., Skokie 17, Illinois

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LITERATURE . . .

Pumps, High Pressure.....Catalog describes Series HP Pumps. Meet an entirely new conception of operating requirements—demanded by modern high pressure processing techniques. Catalog HP-1254.
347 *Philadelphia Pump & Machy.

Pumps, Porportioning.....Design features which contribute to the exceptional feeding accuracy, positive feed rate setting, and initial and operating economies of new Proportioneer described in Bulletin 1140.
488 Proportioneers, Inc.

Pumps, Sanitary.....Offers 18 new features: heavier shaft construction . . . Twin O-Ring Seal that positively prevents product leakage or intake of air . . . reversible sleeve to save shaft wear. 1957 Catalog.
388 Waukesha Foundry Co.

Pumps, Vacuum.....Stokes Vacuum Calculator simplifies calculation of pump performance and selection of pump size for specific applications. Full story on Microvac design features in Catalog No. 752.
366 *F. J. Stokes Corp.

Vents.....Complete Venting Manual shows operating features and special applications of complete Protectoseal line. "In-line" vent avoids frequent, costly and highly dangerous roof-top inspection.
324a *Protectoseal Co.

Services, Processes, Misc.

Extraction.....Solvent decarbonizing, a "paracritical" liquid-liquid extraction process, is the subject of a new 16 p. booklet. Describes process operation in general and its technical and economic advantages.
499A M. W. Kellogg Co.

Extrusion.....32 p. manual contains both practical and theoretical discussions of the fundamentals of thermo-plastic extrusion. Separate sections deal with the screw, the die and post extrusion equipment.
499B Monsanto Chemical Co.

Felt Filtration.....Data sheet No. 18 is an 8 p. presentation of the advantages of this company's felt for liquid filtration. Charts, diagrams show properties and characteristics of fiber bonded non-woven filters.
499C American Felt Co.

Fire Extinguishing Systems, Carbon Dioxide.....Features: all operating parts completely enclosed, no clumsy triggering methods or falling weights, self-contained, easy testing of all parts. Booklet.
478 *Walter Kidde & Co.

Laboratory Equipment.....Catalogue lists and describes a complete line of polyethylene laboratory equipment. Includes such items as bottles, funnels, graduates, centrifuge tubes, hand pumps, drain trays.
499D Bel-Art Products.

Laboratory Equipment.....Specially designed laboratory and pilot plant autoclave for use in conducting reactions at high pressures and under severe corrosion conditions is described in Bulletin 939.
499E Pfaudler Co.

* From advertisement, this issue

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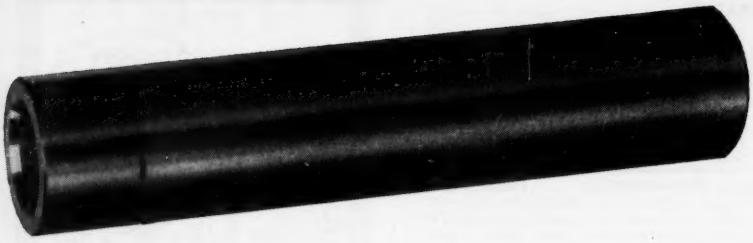

Kennametal's 94 million YME puts the squeeze on "cylinder breathing"

- prevents leakage around pistons
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In making polyethylene, gases are compressed at pressures as high as 35,000 psi. Under such pressures, cylinder liners deform and permit gas to leak around the pistons. This "cylinder breathing" must be held within defined limits.

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LITERATURE . . .

Laboratory Equipment & Furniture .....Line of sectional units designed for interchangeability & flexibility assures a synchronized installation which will produce peak efficiency. 180 p. Catalog 4B & Supplement 55-A.
B508 *Metalab Equipment Corp.

Maintenance.....6 p. folder explains how company's specialized materials, such as liquid and plastic roof resurfacers, effectively and economically increase the value of buildings. Cover material to seal cement against leaks.
500A Stonhard Co.

Metal Processing.....28 p. booklet called "Asarco Products and Processes" is a pictorial review of company's mining, smelting, refining and research operations. Includes detailed maps.
500B Amer. Smelting & Refining.

Microfilming.....36 p. booklet called "New Horizons with Microfilm" covers techniques for unitizing microfilm as they apply in handling engineering drawings, personnel records, reports.
500C Industrial Mktg. Services Co.

Molding.....12 p. brochure called "Check List for Trouble Shooting Polyethylene Injection Molding Problems" outlines causes of burning and scorching, discoloration, distortion, surface blemishes.
500D Koppers Co.

Pharmaceuticals Production.....28 p. booklet describes the organization as well as the operation of this pharmaceuticals manufacturer. Covers company's research, engineering, products and markets.
500E Merck & Co.

Refining, Solvent Mixtures & Organic By-Products . . . . . Technically trained personnel are available to discuss the refining of any solvent mixture or organic by-products. See new booklet.
B355 *Truland Chemical Co.

Safety.....Revised safety folder including list of antidotes for all agricultural chemicals, which contain antidotes for newer insecticides like Phosdrin, Thimet and Guthion. Lists approved handling equipment.
500F United-Heckathorn.

Safety Equipment, Storage Tank..... Company offers Safety Bulletin Series on "Flammable Liquids, their characteristics, hazards and safe handling." Includes: conservation type vents, tank openings, etc.
324b *Protectoseal Co.

Wood Engineering.....25th anniversary booklet on company, clearing house for technical data on designing and building in engineered timber, cites activities and facilities serving the wood industry.
500G Timber Engineering Co.

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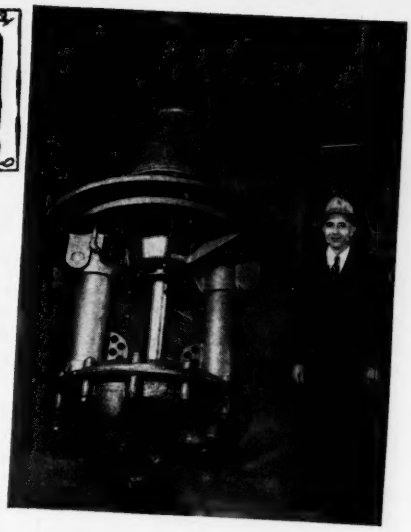

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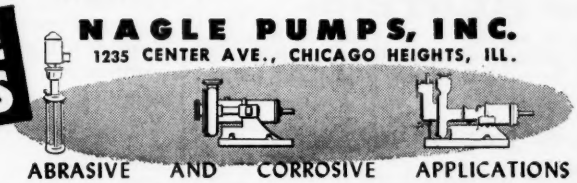

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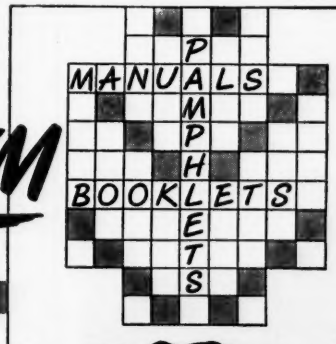

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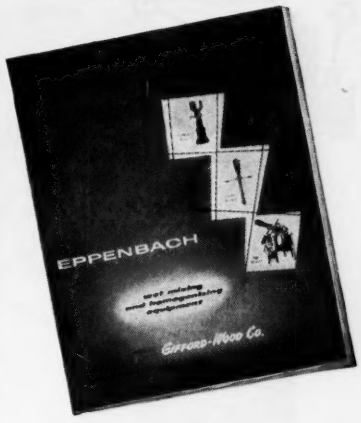

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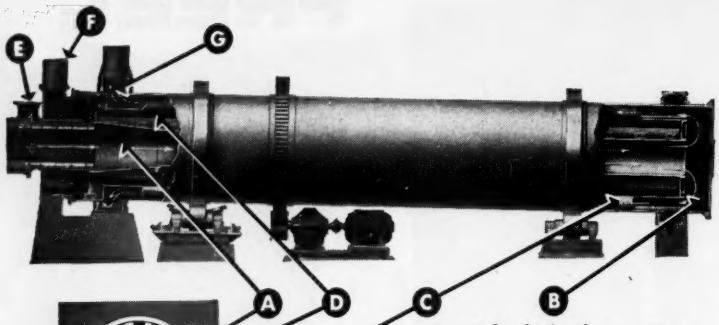

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D. Drying area for material.
E. Feed head.
F. Vapor discharge head.
G. Furnace gases discharge head.

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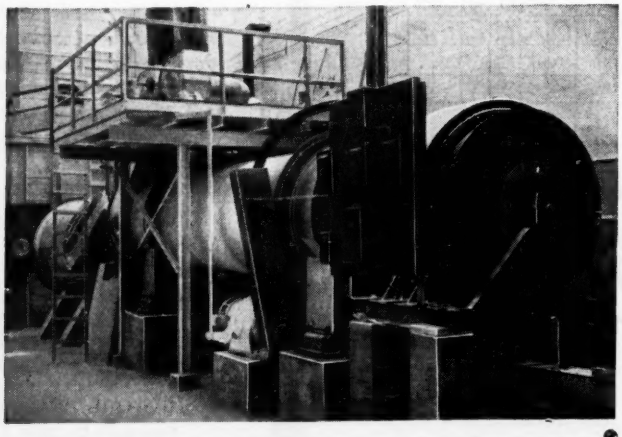

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- **Your complete index to chemicals, materials, equipment and services, taken from this issue's advertisements, new products departments and guide to technical literature (p. 462).**
- **Products listed feature code numbers which show the page on which they appear, L (left), R (right), T (top), B (bottom) indicate ad location; A, B, C, etc. and a, b, c, etc. identify specific product items on an editorial page or in an ad.**
- **You can get information on any listing by circling its key number on the Reader Service Postcard (see inside back cover). Replies will come direct from the companies manufacturing the products.**

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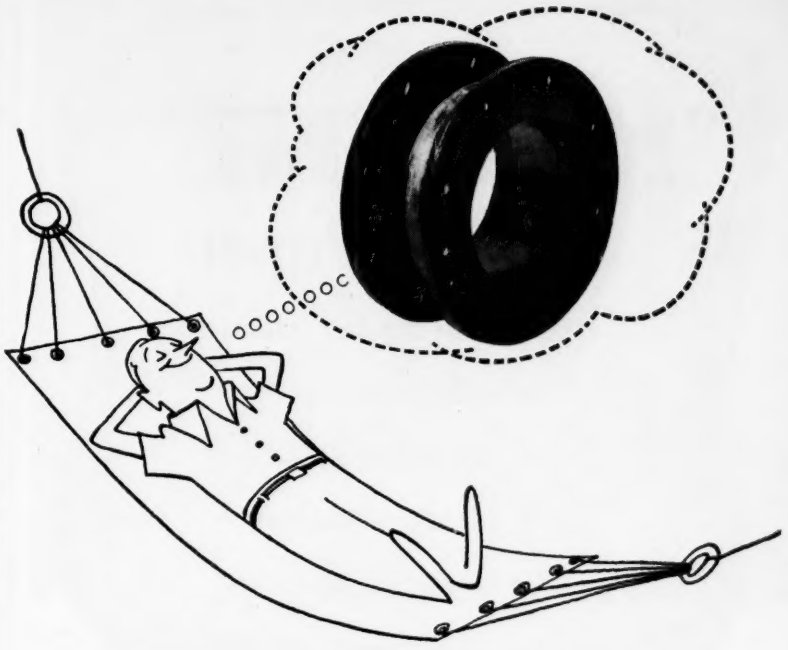

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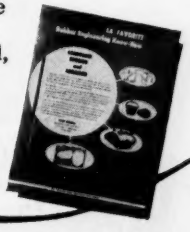

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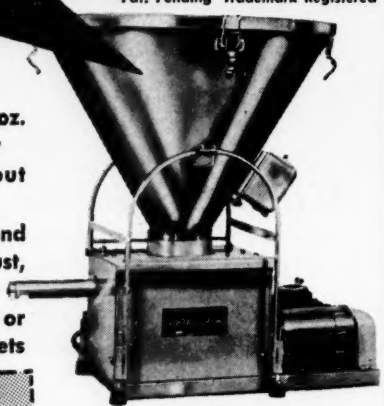

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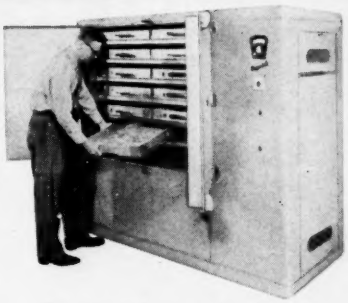
• It is your complete index to chemicals, materials, equipment and services, taken from this issue's advertisements, new products departments and technical literature.

• Products listed feature code numbers which show the page on which they appear, L (left), R (right), T (top), B (bottom) indicate ad location; A, B, C, etc. and a, b, c, etc. identify specific product items on an editorial page or in an ad.

• You can get more information on any listing by circling its key number on the Reader Service Postcard (see inside back cover). Replies will come direct from the companies manufacturing the products.

New Truck-loading . . . Batch Type

Despatch CHEMICAL DRYING OVEN



- **Models available in 3 temperature ranges**
- **Controlled exhaust of saturated air**
- **Complete removal of explosive volatile**
- **Available for gas, electric or steam**
- **Optional equipment includes loading truck, extra shelves, timed exhaust, special controls and larger capacities**

Write for Bulletin 100

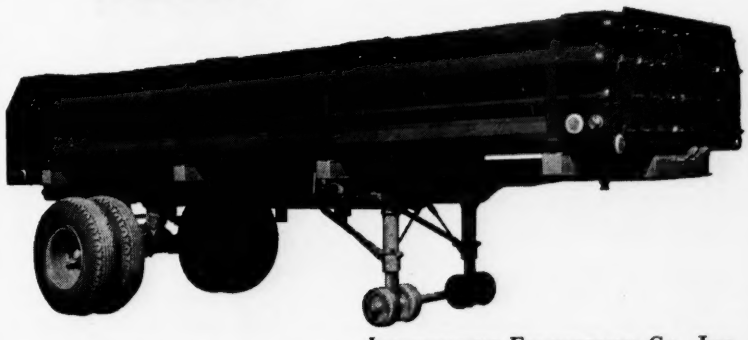
For convenience o. handling large batches of chemicals, the Despatch No. V-39 is the answer—ideal, too, for finish baking, curing, aging, dehydrating or preheating any heat reactive product. The V-39 easily handles big fully loaded floor trucks that can be rolled right into the oven. Specially arranged horizontal ducts provide a uniform, high volume blast of air over and under each shelf to assure thorough drying. Available in 3 temperature ranges: Standard 100°-500° F.; Heavy Duty 250°-650° F.; Super Duty 450°-850° F.

DESPATCH OVEN CO. Established in 1902

405 Despatch Building
Minneapolis 14, Minnesota

with* INDEPENDENT *Gas Supply TRAILERS

TRANSPORTING — Argon — Carbon Dioxide — Helium—Nitrogen— Oxygen — Boron Trifluroide — Hydrogen — Ethylene. Trailer capacities from 187,000 cu. in. to 750,000 cu. in. water capacity. Trailer tubes ICC3A-2400 Specifications with 2400 PSIG Working Pressure.



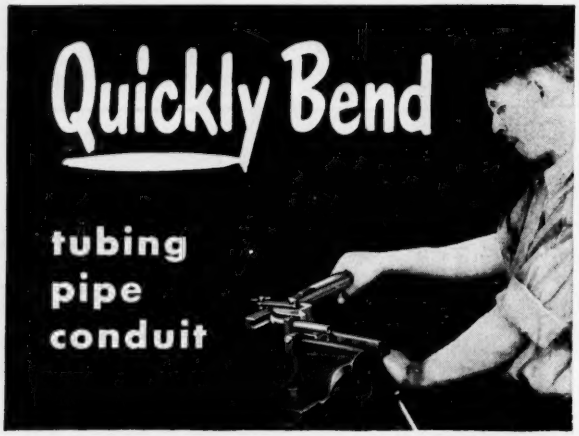
Sizes and weights to meet all State requirements.

Can be mounted on bases for permanent storage.

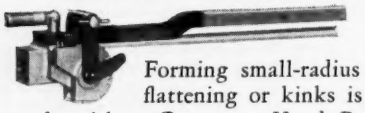
INDEPENDENT ENGINEERING CO., INC.

CONSULTING · RESEARCH · DESIGNING

O'FALLON 7, ILLINOIS



... with a Greenlee Hand Bender



Forming small-radius bends without flattening or kinks is simple, speedy work with a GREENLEE Hand Bender. Lets you "custom tailor" your pipe, tubing, and conduit installations right on the job. Especially designed to form neat bends for sharp corners, nooks and other close quarters. Various models and sizes. Write for free Bender Book.

TOOLS FOR CRAFTSMEN
GREENLEE

GREENLEE TOOL CO., 2424 HERBERT AVE., ROCKFORD, ILL.

KUTZTOWN *Skill*

creates a SPINNING TABLE for making Centrifugal Castings

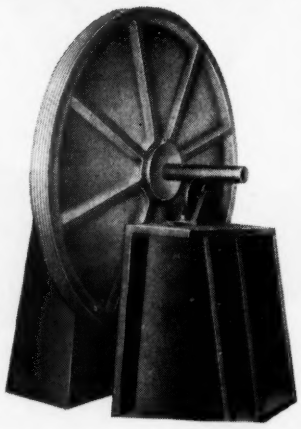
Centrifugal casting is in effect "liquid forging" or pressure casting, in that the molten metal is forced against the mold wall under relatively high pressures, compared to the usual gravity head in an ordinary static casting.

This dynamically balanced high strength Spinning Table was made for the Janney Cylinder Company of Philadelphia, Pa., one of America's leading producers of Centrifugal Castings.

It weighs 4800 lbs; 80" O.D.; 5⅝" thick; outside rim has 5 V-belt grooves for driving purposes. It was cast of Ductile Iron and machined in our own plant.

Whether the castings you need are classified as usual or unusual, we are anxious to prove to you that Kutztown castings are accurately and economically produced.

We'll be happy to place your name on our mailing list to receive regular issues of the "Kutztown REVIEW."



• GRAY IRON • PRESSURE IRON • LO-ALLOY IRON • HIGH TENSILE IRON • DUCTILE IRON • NI-RESIST

KUTZTOWN FOUNDRY & MACHINE CORP.
KUTZTOWN, PENNSYLVANIA

READER SERVICE . . .

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